Complete
HINTS and TIPS
For Automobilists.

FROM

The Autocar

Being the Fifth Edition of "Useful Hints and Tips" thoroughly revised and amplified.

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PREFACE TO THE FIFTH EDITION.

"THE AUTOCAR" commenced to publish "Hints and Tips" as a regular weekly feature in 1902, *and every week from then till now a page is devoted to items of a practical nature under this heading. As the volume of information accumulated, constant requests were made that "Hints and Tips" should be reproduced in book form. This was done, and the book has become one of the most useful and most appreciated in the automobilist's library, and enjoys a wide sale all over the world.*

It has now passed through four editions, and the present (the fifth) is to all intents and purposes a new book. A very large number of new paragraphs have been added, and very many of the old ones have been expunged, though all of the older ones which were likely to prove of general use have been retained, particularly those which might be of service to owners of cars some four or five years old. The present edition contains a greater number of pages of information than any of its predecessors, and is likely to prove even more useful.

The classification of the paragraphs into the different sections has been made as distinct as possible under the circumstances, but readers in doubt as to whether all the references to any particular subject are exhausted in any one section should refer to the complete index, a free use of which will be always found the quickest method of consulting the book.

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Piston Rings and their Fitting.

1 Scarfing or half-lapping the joints of piston rings has never been found by steam engineers to pay for the trouble involved, as the leakage through a narrow slot is very slight, and checked only in a small degree by scarfing alone. Fig. 1 illustrates an excellent design which is better able to hold compression after lengthy service.

Any advantage arising from boring rings eccentrically is discounted by a deeper annular channel in the piston and unequal wear of the edges, due to diminishing surface, and

there are makers of repute who ignore this point. When a ring fits the bore the radial pressure needs to be very slight, as it is heavily increased by the gas which passes inside. Even when a ring is a little slack edgewise in the groove, there must be—except when the piston is changing stroke—one edge or the other in contact which checks escape.

The cylinder bores of marine engines are often worn larger at the ends by the inrushing steam at maximum pressure penetrating inside the ring and expanding it with undue force. Means are often taken to prevent this by restraining the ring from opening too far—a practice generally favoured by the Admiralty. In large steam engines leakage is minimised by opening twin rings axially as well as radially, and the idea carries several patents.

The subject has received much careful thought from steam engineers, and it has long been recognised by them that no type of floating ring without frequent axial and radial adjustments can remain tight under working conditions. Also that excessive radial pressure can be a greater evil than leakage; and experience has also proved that a highly glazed cylinder bore is doubtful evidence of a minimum friction. In the merchant service, when a packing ring is adjusted to sustain its own weight in the cylinder, it is considered to be sufficiently expanded.

FIG. 1.

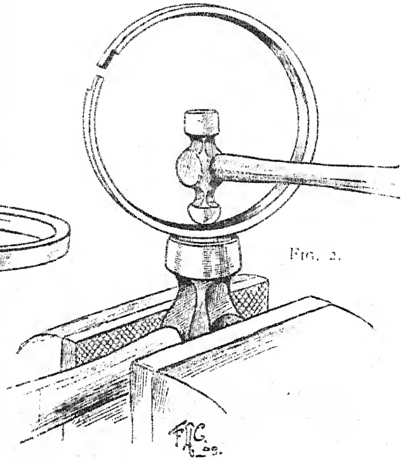


FIG. 2.

Now, if steam-tight pistons be of paramount importance in marine engines, they should be still more so in petrol motors. Steam which has escaped past the high pressure and intermediate pistons can still do useful work in the low pressure cylinder, but the gas which has passed the piston of a motor is as the water in the tail race of a mill. More-

over, the loss by leakage past a small piston is greater relatively than that past a large one, in inverse proportion to the squares of their diameters.

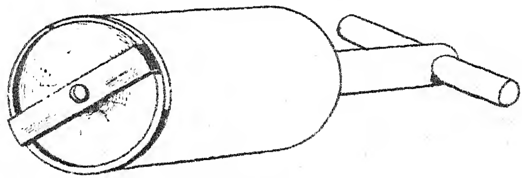


FIG. 3.

Should a motor cylinder be worn unequally, it is clear that no ring can fit well, but serviceable rings are often scrapped because they show a black mark on the outer surface. To these, with a little care and patience, a new lease of life may be given.

Set a hammer face upwards in the vice, stand the ring on it, and, starting from the middle, tap inside with the peen (knob) of a light hammer, gradually reducing the force of the blow as the slot is approached. It is better for the ring to be in the cylinder while doing this, but more difficult to use the hammer. If skilfully done, a ring may be stretched to reduce the slot, and expanded to restore the spring. Then a trial in the cylinder and a few artistic touches with a file complete a ready and cheap improvement. The value of the popular emery-grinding process is questionable, as it wears the edges of the rings and the sides of the grooves, especially when done with a twisting motion, as the ring seldom turns with the piston.

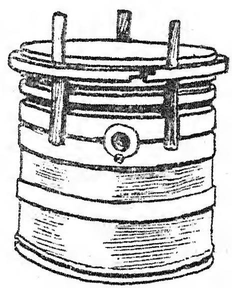


FIG. 4.

When fitting a new ring into an engine, the ends—or landings, to be technical—should be left so that the edges overlap slightly when the ring is in the cylinder. Then make a plug of yellow pine an easy fit in the cylinder and square one end. Lay the ring on this end with a small batten across secured by a screw through the centre, but not holding the ring tightly. Smear the bore as evenly as possible with a little vermilion and lubricating oil mixed to a paste, and move the ring to and fro in the cylinder while held square

by the plug. Generally, it will be found to bear hardest at each side of the slot. File such places carefully with a 6in. smooth file, try in again, and continue. When the ring fits fairly well all round, the overlap of the ends should be absorbed; if not, file them until the edges have about 1 mm. clearance when the ring is in the cylinder.

If the ends of the rings be hard butted against one another when in place in the cylinder, they may be buckled by expansion when hot, and make starting a two-man job.

Before springing the ring over the piston it should be tried all round in its groove to make sure that it is not too tight edgewise, else when in place an attempt to remove it may be fatal. Three or four old contact blades inserted, as in fig. 4, between the ring and piston are useful as guides for the former when being fitted into position.

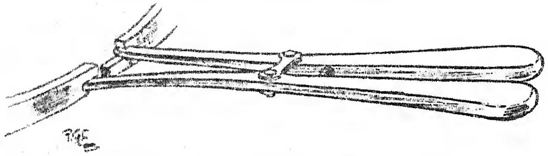


FIG. 5. (Note figs. 2 and 5 are drawn out of proportion for the sake of clearness.)

To hold a ring while the edge is filed, lay it on a flat piece of wood, drive four small brads around, and file it on one edge only.

The rings should be fitted with the slots inclined to the left and right alternately, so that the escaping gas shall drive the rings round in opposite directions, thus preventing the possibility of the slots remaining in line—at least, such is the theory.

A useful tool for putting on and taking off piston rings is that shown in fig. 5. These ring expanders can easily be made with two pieces of steel linked together as shown by a couple of old chain links. Risk of breakage is thereby minimised.

Fitting New Piston Rings.

2 The tools required for fitting a piston ring are a large sheet of emery cloth—No. 1 grade, but not coarser—a thin, fine, flat file, a pair of lead clips, and a vice. After scraping any deposit of burnt oil which may have accumulated in the grooves of the piston, three rings are selected—a suitable one for each groove. The ring should be turned

all round its circumference for the groove into which it is to fit. This, of course, can be done without springing it over the piston. The ring should just fit easily, but not too much so. and on no account should one which is at all tight in its groove be fitted in that condition. It should be laid flat upon the piece of emery cloth and carefully rubbed down until it fits the groove it is to occupy. It is advisable to fit each ring individually, in order to ensure its not eventually finding a position in another groove. We next have to turn attention to fitting the ring into the cylinder itself. The ring should be pushed at least an inch up the cylinder, and should be sprung outwards with the fingers. If the ring is not of correct diameter, but slightly larger than the cylinder bore, this will be shown at the angular slot by the edges of the ring being out of line. Now take the fine file and carefully remove from the slot a small quantity of metal, being particularly careful to keep the edges of the slot parallel. Sufficient metal must be removed, little by little, until the ends of the ring come into line the ring is now ready to place in its position upon the piston.

When fitting new rings, a slight space should be left between the ends of the ring, otherwise, when the ring gets hot, the expansion may cause the ends to abut and to jam in the cylinder; this jamming being sometimes sufficient to stop the engine. This defect is liable to puzzle the novice badly, as the moment the engine stops, the heat passes from the rings into the surrounding metal, and the engine becomes quite free.

Replacing the Rings.

3 Very great care is necessary in placing the rings in position upon the piston, as, owing to the nature of the metal, they are very liable to break, and this seems to be more the case with new rings than with old ones. It is probably accounted for by the fact that the heat to which the latter have been subjected while running has tended to make them more springy. The bottom ring should be placed in position first, and, it may be possible to open this sufficiently to pass it over the connecting rod. If this is not the case, it must be passed over from the top of the piston, and by a little careful manœuvring and taking it down over the two top grooves a little skewwise it may be dropped into the bottom groove without trouble. The middle and top rings may then be put into position. A warning note should be given that it will be found more troublesome if the top ring is put in first, trusting to put in the second and third

ring over it, than the method just detailed. It will be very apparent if one thinks for a moment that it would be difficult to spring the top ring close in and at the same time pass another ring over it. The inexperienced man has often been seen to attempt this method, but eventually to give it up, as the other method is far more expeditious and satisfactory.

Replacing the Cylinder.

4 We are now ready to replace the cylinder, but before doing this the slots in the piston rings must be placed at points equidistant from one another, and care should be exercised that they maintain this position, or else a loss of compression will result. Nearly every cylinder is slightly bell-mouthed at its bottom end, and this is done chiefly to facilitate the insertion of the piston and its rings. This, again, is really an operation which demands two pairs of hands—one person to drop the cylinder into position, and the other to close the rings in as they enter the cylinder. Single-handed, this is a somewhat difficult operation, and is likely to be attended with a shifting of the piston rings, so that one is never really satisfied that the slots in the rings are in their correct positions. Although it is comparatively easy to put a single cylinder back on to its piston, a good many find difficulty when the cylinders are cast in pairs, as they cannot "dodge" the rings into the cylinder barrels simultaneously. The job is greatly simplified by taking the precaution to place the cranks up and down, so that one piston is at its highest point and the other is at its lowest. This means that the pair of cylinders can be dropped straight over the pistons, the rings of the upper piston being guided into the cylinder before those of the lower piston have to be worried about. When it comes to dropping one of the monobloc castings of four cylinders on to four pistons it is still best to work this way, so that only one other pair of hands are required, and that the two upper pistons may be guided into their cylinders first and then the two lower. The cylinder being bolted down to the crank chamber and all the connections made, a dose of new clean lubricating oil should be inserted in the crank chamber and the motor started up. On first running, it will be noticed that the compression is very bad indeed, which to the novice is a very uncomfortable result, for after fitting new tight rings he naturally expects at the outset to find a very high compression, and the motor difficult to turn in starting up. It must be remembered that the surfaces of the rings when new are in a rough condition on their face,

and that they do not attain their best form until they have assumed the glass-like face which may be noticed upon the inside of the cylinder and upon the greater portion of the old rings. This surface can only be obtained by working for some time. It is advisable, too, when running the piston rings in to over-lubricate the engine slightly, and to renew the charge at frequent intervals. If the rings have been properly fitted and the engine kept well lubricated, many hundreds of miles —perhaps running into several thousands—may be covered before the engine will require a new set of piston rings.

To Prevent Piston Rings Turning.

5 Some makers, to prevent the piston rings turning round in their grooves, drill a hole in the slot in the ring, and screw a small peg into the base of the groove. Many existing pistons can be treated in this manner. However, it is not always satisfactory to do so, for there is not always sufficient metal in the piston in which to screw the pegs.

Loss of Compression: Causes.

6 One of the principal causes of the loss of compression is a bad seating of the inlet or the exhaust valve. The latter gives more trouble, as a rule, than the former, it having more work to do, and, moreover, has to withstand the great heat to which it is subjected by the outrushing exhaust gases at the end of each power stroke. It should be the invariable rule to examine the valves first.

The signs of a worn valve are dark patches or pitting on the conical face of the valve or its seat. In many cases, it will be found that the valve itself will be pitted and marked much more than the seat; the one being good, and the other only showing slight signs of imperfection should not be allowed to pass.

The next point at which compression is likely to be lost is the imperfect fitting of the piston and its rings in the cylinder. The ideal conditions for a piston working in a cylinder would be a perfect fit between the piston and the cylinder, but as the question of heat has to be considered, it is not possible to attain this ideal fit, for if the piston were too tight, the heat generated by its frictional contact would be so intense as altogether to prevent its working. As it is, the difference in measurement between the piston and the cylinder walls does not amount approximately to more than one-hundredth part of an inch. There is this difference to be provided for, however, and although to many of our readers the hundredth

part of an inch may seem a small matter, yet it allows of the escape of a very appreciable quantity of the explosive gases from the cylinder before the charge is fired, and is of vital importance in the construction of an engine such as that employed in driving a motor vehicle. The piston, then, having of necessity to be smaller in diameter than the cylinder, it becomes necessary to make a gas-tight joint by the aid of piston rings. For this purpose, three or more rectangular grooves are cut in the upper end of the piston, and into each of these grooves is sprung a cast-iron ring so constructed (being severed at one point) as to have in itself a certain amount of spring which keeps it in constant contact with the walls of the cylinder, and so forms the necessary joint. In course of time, these rings will wear to such an extent as to permit a portion of the compressed charge to escape, and, what is more destructive, portions of the ignited gas also escape by them, thus tending to their rapid destruction when once they begin to give way. It is invariably the top piston ring which gives way first, as this does the bulk of the work in preventing the passing of any part of the compressed or exploded charge. The first ring having failed, the remaining ones go in succession, so that the loss of compression is on this account spread over a fairly long period of time. If all the rings went simultaneously, then the loss in compression would be so sudden that one could turn to the engine and immediately go to the piston rings as the cause of the trouble; but as these go successively, the power diminishes very gradually, and it is not until the rings are really bad that one turns to these.

Another frequent cause of loss of compression is a leak at a valve cap, that is, the plug at the top of the cylinder which must be removed before the valve can be lifted out. These valve caps are usually of large diameter, considering the leverage available to tighten them up, and more often than not the available area for the copper-asbestos washer is very small. When a valve cap is being replaced, care should be taken to see that the facing on the cylinder is quite clean, and that no carbon deposit or grit has lodged at this point. The same applies to the facing on the valve cap itself. Yet another source of loss of compression is at the sparking plugs, not only between the sparking plug and its seating on the cylinder, but through the glands of the sparking plug itself. To trace such external compression leaks, a small quantity of oil may be spread round the seatings by the aid of an oilcan, when, if the engine be turned, and there is a leak at any of these points, bubbles will be seen to arise in the oil.

How to Test Compression.

7 The testing of the compression is a somewhat difficult operation to obtain satisfactory results, as so many elements enter into the conditions. These we will touch on after describing how compression may be tested. The piston should be freed in the cylinder by injecting a small quantity of petrol or paraffin. The starting handle should be put into engagement, and should be revolved until resistance is felt on one upward stroke only. It is by the amount of resistance which is felt on the starting handle that the amount of compression in the engine may be judged. In order to obtain a correct idea of the amount of compression there is in the cylinder, a slow steady pull should be given to the starting handle—not a sharp, quick jerk, such as is necessary in the starting operation. In order to free the valves and to get the engine as nearly as possible into its free working condition, two or three sharp revolutions by means of the starting handle may be given to the engine, after which the compression stroke should be felt, and then a long steady pull on the handle taken, from which to judge the amount of compression. In doing this, the operator can steady himself by placing the left hand on the front part of the dumb iron, while with the right hand he grasps the starting handle. The amount of compression in the cylinder is judged by the length of time occupied in overcoming the resistance. Incidentally, the power of the operator is a factor which also enters into one's judgment. For a two, three, or four-cylinder engine, it is necessary that each cylinder should be tested independently. This is more easily done by inserting between the valve lifter and the valve stem on the exhaust side two copper coins, which will give a sufficient lift to the valve to prevent any resistance from those cylinders which are not being tested beyond the normal frictional resistance. By this means each cylinder may be tested separately.

Correct Testing.

8 A more satisfactory method of ascertaining the correct compression in the cylinder is to have an adapter made to fit into the sparking plug orifice, this attachment carrying a small pressure gauge such as is used for tyre inflation, the dial of which is marked up to 100 lbs. per square inch. This should be sufficiently high for any engine. The gauge itself should be screwed into the adapter, so that the extra amount of compression space obtained by the use of the device may be as little as possible. It only now remains for

the gauge to be screwed into the cylinder, and then for the operator to watch the highest point to which the index registers, in order to obtain the exact amount of compression of the particular cylinder under test. This figure, of course, will not correctly indicate the amount of compression which will be present when the engine is actually working. In this case, it will be higher than that indicated. Incidentally, we may mention that suction may also be tested in a similar manner by the fitting of a gauge, the dial of which is marked below zero, and not above as with the compression indicator. No hard and fast line can be given as to the amount of compression which should be registered, for this varies with many engines according to the speed at which they run, and the diameters of their flywheels to a certain extent. The average compression, however, is about 75 lbs. to the square inch. The most satisfactory and practical way of finding out the condition of one's engine is to test the compression when the engine is in good going order, and to make a record of the compression and suction (if tested), and to use these as standards of comparison when the engine is out of order and needs attention in the manner already indicated. Measures must then be taken to restore the engine to its normal condition of working.

Valves and Valve Grinding.

9 The efficient and silent working of an engine is dependent to a great extent on the condition of its valves, and such attention as these require consists in the adjustment of their tappets and grinding in.

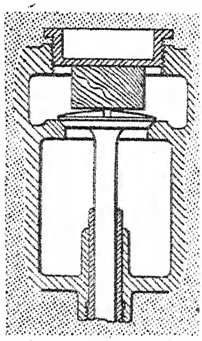


FIG. 1.

With regard to the first, it is always advisable to effect the adjustment when the car comes in from a run, for, assuming that the engine is then in its warmest condition, it is obvious that no further expansion of the valves can take place, so that it is better to effect the adjustment after a run than when the engine is cold. The tappets should be adjusted so that only the slightest possible shake can be felt.

If it is suspected that one cylinder of four is very bad in regard to its compression, this can be tested by turning the engine over by hand with three compression taps open

alternately. It may be found that the tappet of this cylinder is either adjusted too high, so as to prevent the valve from seating, or possibly some grit may be in evidence between the face of the tappet and the foot of the valve stem. When valve tappets are fitted with fibre washers, these washers sometimes become recessed, and occasionally the valve will

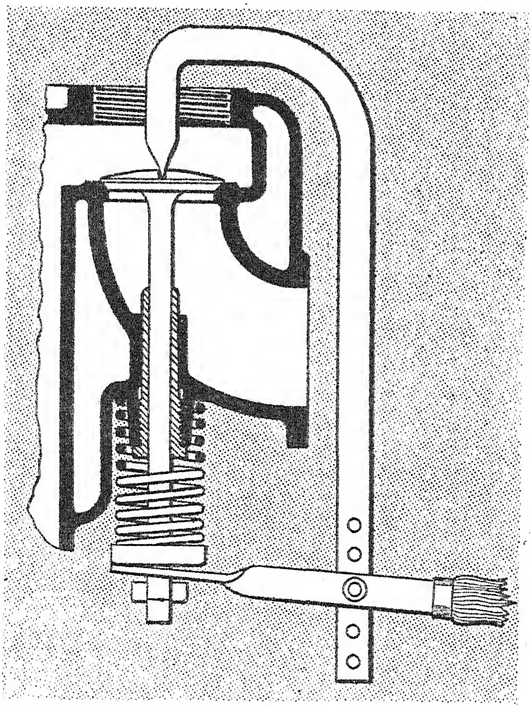


FIG. 2.

fail to drop into the recess, but catch up on the side, and so be prevented from seating. In such a case the tappets should be removed and filed off flush with the fibre, or, better still, new fibre washers should be fitted.

Valve grinding is a somewhat laborious process, but it is one which often improves the running of the engine, so

that it should be made a periodical performance. There are certain difficulties, chiefly in regard to the removal of the valve, which can to a great extent be overcome by following the hints given below. When removing a valve spring, it is a great help to interpose between the head of the valve and the valve cap a block of wood, as shown in fig. 1, which will prevent the valve being raised when the spring is lifted. If now the valve spring and cotter be raised, the valve cannot rise. Both hands are thus left free, and the process is greatly facilitated.

There are a number of tools on the market for compressing the valve springs, and it is well worth while to have one of these in the garage. Before actually purchasing, it is well to see that the tool in question will actuate the valve spring in the particular engine for which it is intended. All these devices appear to work, but when applied to some engines it is often found that for some reason, which differs with every engine, one tool will not work, whilst another type will. For those who are handy at making tools, that shown in fig. 2 can easily be made out of some metal strip. This tool has the advantage that it presses down on the top of the valve, preventing it rising, and obviating the necessity for the distance piece shown in fig. 1. This tool will not fit many engines, but is one of the best where it can be used.

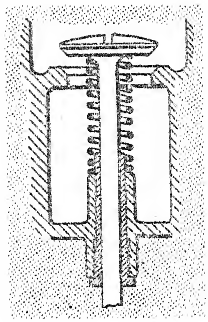


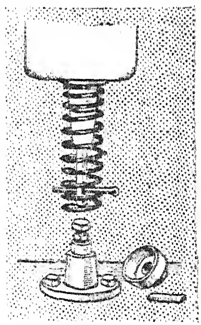
Fig. 3.

After removing the valve, the cotter and spring should be removed and cleaned. A light spring should then be found which is just sufficiently strong to keep the valve off its seat, as shown in fig. 3, and the tappet head should be slacked off so that there is no possibility of the valve stem bearing on the tappet. The tappet can be readjusted after grinding in the valve.

In the actual grinding in, it is best to use a special preparation for the purpose, although ordinary emery powder will suffice. This should be mixed with thin oil or paraffin, and applied to the valve face. The simplest way is to rub a little of the compound on the valve face, and lubricate it well from an oilcan. The valve should be turned either with a screwdriver or brace bit, but in either case the valve should not be rotated through a complete circle, but oscillated back-

wards and forwards, and from time to time the screwdriver should be removed, allowing the spring to lift the valve. This allows the emery and oil to mix up again on the valve face, and prevents a ball of emery collecting and running round in a circle so as to cut a groove. When the spring is not used, it is necessary to lift the valve occasionally with the finger. The pressure applied should be slight, and it is advisable to use an excess of oil or paraffin in preference to an excess of emery. An excess of the cutting compound merely causes clogging. The valve should be taken out from time to time and wiped to ascertain its condition, and it is finished when both the valve and the valve seating are perfectly clean and free from spots or pits. The replacement of the valve is effected in a converse manner to its removal. If the particular type of valve tool so require, it may be advisable to use the distance piece as shown in fig. I. After the valve is replaced, the tappet head should be readjusted, and the engine run a few minutes to ascertain if the valve be in proper condition. —ERIC W. WALFORD.

Removing Valves.



10 I used to experience considerable difficulty in removing valves whilst the springs were in position until I hit on the following plan: Withdraw the key, and in its place insert a split pin or nail long enough to protrude either side of the valve spring, as shown in the sketch; then turn the split pin to the right, and it will then be found that the valve spring will act as a thread, the valve rising until the head passing above the combustion chamber can be gripped by the fingers.—GEO. E. DICKER.

A Quick Way of Fitting Valve Springs.

11 By compressing the spring considerably by tying it up with string on each side, then placing it in position round the valve stem guide, the valve can be inserted and the spring tang threaded through the stem as easily as shelling peas. Of course, as soon as the spring is in position the string can be cut.

Absence of Compression after Valve Grinding.

12 The owner-driver not infrequently discovers, after he has laboriously ground in his valves, that even the very

poor compression which existed before he began work has disappeared, and that as a result of his labour he has not enough compression wherewith to start his engine. This annoying experience may be due to imperfect cleansing of the valve chest. Particles of carbon or abrasive have been left therein, and prevent the valves from sitting down hard on their seats. In emergencies the compression may generally be regained by twisting the valves round under pressure from the brace or screwdriver ; but if the obstruction be a particle of abrasive, scoring is likely to ensue, and will nullify any good effects expected to result from the grinding. Obviously during the process of valve grinding the orifices to the combustion chambers should be plugged with waste or cotton wool, and the valve seating and chest should be carefully cleaned with a wet rag and sluiced with paraffin before the valves are replaced.

A Valve Grinding Tip.

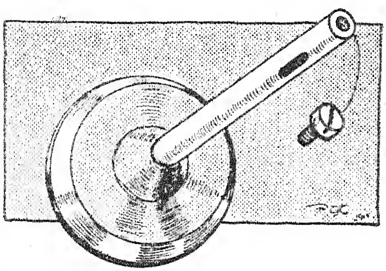
13 All the more careful manufacturers number their valves. For instance, on a four-cylinder engine the valve cap orifices are numbered on the cylinder casting one to eight, and the valves themselves are numbered to correspond. When removing the valves to grind them, care should be taken to number them if they have not already been numbered by the makers. Of course, they cannot be numbered in figures as the makers would number them, but the heads can be dotted with a centre punch, or what would be safer for the average amateur would be to tie a label on each, or to use some other simple method, such as a numbered box, so that the valves would not be mixed up. The same remark applies to the valve caps. No matter how well an engine may be made, it is desirable to keep the parts in the same order as they were before taking the engine down, as after a certain period of work these parts become more or less bedded into position, and even with the highest standard of accuracy there are small differences, such as those which occur in valve stem lengths. Not only so, but the valve heads themselves become bedded to their seats, and as each was individually ground to its seating originally, the chances are a great deal more grinding will be required to bring about a satisfactory face on both valve and seating if the valves be changed over. As to the valve caps, it will generally be found if they be changed about that one or other will be slightly tight or loose in its thread.

Sticking Valve Stems.

14 It is well known that firing back into the carburetter and popping are usually caused by too weak a mixture, but there are times when this occurs, although the mixture is not too weak, and when this is the case it is highly probable that the valve stems are sticking in their guides. The trouble can often be overcome by the simple expedient of squirting some paraffin up each valve stem through the springs, so that the guide may be freed of any slight deposit of thick oil which may have gradually collected and thereby made the stem somewhat tight. If this does not effect a remedy the valves should be lifted up one by one, and any that are sluggish in springing back into position should have the springs removed. Each springless valve can then be moved up and down freely with the fingers, and if one be found to be stiff it must be taken out and eased, but this should only be done when cleaning fails to effect a cure, for before any attempt is made to reduce the stem it should be thoroughly cleaned, and the same applies to the guide in which it works. If it still remains stiff, the stem should be polished with emery cloth, care being taken to equalise the polishing all round and also to avoid overdoing it, as a very little is sufficient to make all the difference required. If the stem be reduced unnecessarily, so that it becomes a loose fit in the guide, wear is set up, and in extreme cases air leaks in round the stem, thus causing a weak mixture by supplementing the usual supply through the carburetter and air valve.

Lengthening a Valve Stem

15 In course of time a valve stem that has been long in commission will shorten, owing to the hammering action of the tappet against its lower end. This shortening means incorrect opening and closing of the valve, both as regards the instant at which these take place and the lift. If the valve is an exhaust valve, loss of power ensues, and the symptoms of overheating are set up. The proper cause is frequently overlooked, and much money is spent on having the pump and water circulation examined and at-



tended to. The valve stem can be lengthened in a very simple manner, which saves the expense of fitting a new valve. The foot of the valve stem is softened, if necessary, and a small hole drilled axially in it, and tapped. Into this hole is screwed a cheese-headed screw, which is filed down to the same size as the valve stem, and of sufficient length to take up as much of the clearance as necessary.

Another method if the stem is of very small diameter is as follows: Braze a piece of tool steel to the end of the valve stem; before this has had time to cool, plunge in water to harden it, and grind it to the correct length. This makes a splendid job—in fact, better than new, as the end of the valve stem has a perfectly hard surface, and wears much longer. Also there are fewer loose parts, and consequently less wear than in the method suggested above. An old and attenuated valve treated in this manner will work quite as well as a new valve. These remedies, of course, only apply to engines without adjustable valve tappets.

Warping of Valves at High Temperatures.

16 From time to time I recently experienced a sudden falling off in power of my car and sluggishness in running, and even after the car had been in the maker's hands the trouble remained uncured.

I received various reports from experts (?) without avail, and almost every portion of the car had been under suspicion. Finally I let the matter drop for the time being, but shortly afterwards I ordered a set of valve truing tools, as I was struck with the utility of the idea.

When ordering these tools I mentioned the trouble I had experienced, and after some correspondence with the Southern Automobiles, Ltd., Blackheath, London, S.E. (the manufacturers of the tools), they offered what turned out to be a solution of my troubles, namely, that the valves of my engine warped at high temperatures, due to the inherent stresses set up in the rough stampings during the course of production.

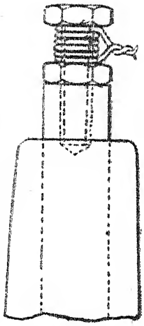
They suggested that if I trued the seatings and fitted a set of nickel steel valves my troubles would cease, and such, I am pleased to say, has been the case. Since then I have fitted a set of nickel steel valves to my motor boat, with greatly improved results.

A word of warning will not be amiss. A sample valve or part should not be sent for guidance without first seeing that the sample fits the engine, as in spite of the fact that I gave the engine number, year, etc., the manufacturers sent

an unsuitable valve, which caused a great deal of trouble, delay, and extra expense.—POPPET.

Valve Tappet Adjustment.

17 An engine which is normally quiet in running will sometimes develop a tapping or knocking noise, due to one or more of the valve tappets requiring adjustment. Absence of noise from this cause is obtained when severe impact between the tappet and the valve stem is obviated. It is quite clear that if the tappet be moving fast before it commences to lift the valve severe impact will occur and noise will result. The tappet should be adjusted so as very nearly to touch the valve stem. When the engine is hot at the end of a run the tappet could be adjusted up so as actually to touch the valve stem. The valve, being hot, will not stretch any more, and when the tappet is adjusted in this way very good results can be obtained. In actual measurement about three thousandths of an inch clearance when the engine is cold is what is required. A good test by which it may be ascertained whether the tappet requires adjustment is to run the engine slowly and to put one's fingers on the valve washer, and if any shock can be felt at the time the valve is raised the tappet should be adjusted.

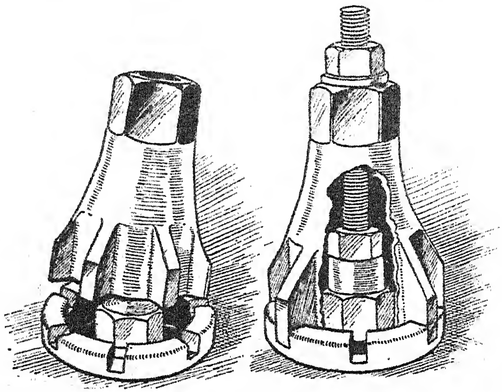


It sometimes happens that a tappet will not retain its adjustment, the locknut not holding well. In such a case the arrangement shown in the sketch can be used. In this case the tappet should be adjusted as required, and in the space between the tappet head and the locknut wire may be coiled and twisted up as shown. If this is done the tappet cannot slacken down. The symptoms of a slacked off tappet are the apparent running on one cylinder less than the correct number, but there is no misfiring.

To Remove Valve Caps.

18 This tip deals with the valve caps of Wolseley cars, but there are a number of makes to which it applies equally. On the Wolseley car the valve caps have rims which have seven indentions. When it is desired to remove the valve caps a castellated spanner will be found in the toolkit. The teeth of this fit into the slots in the valve caps, and a spanner is, of course, used to turn the tool. The difficulty is to keep the castellated tool in position, for as soon as the

spanner is strongly applied the tendency is for it to lift, as shown in the left-hand illustration. The whole difficulty is due to the castellated spanner lifting up when leverage is applied to it, and it is most difficult to remove the valve cap, owing to this tendency. Obviously the thing to do is to hold down the castellated valve remover so that it cannot tip out of position. To effect this we took an old sparking plug which fitted into the plug holes in each of the valve caps, and screwed a bolt into the base of the old plug. This was long enough to project through the top of the castellated spanner, so that a washer and nut could be applied. All that one has to do is to remove the sparking plug, or if the car has not two ignitions there is a plug in one cap and a bolt in the other These are taken out. The old plug is screwed into the hole,



the castellated spanner is dropped into position, and then the small nut on the top is screwed down. There is no need to use the spanner, as there is no necessity to screw the adapter into the cap tightly. Indeed, both it and its bolt can be tightened sufficiently by hand. Having done this, the valve cap removing tool and the valve cap are practically one, and a good long spanner can be applied to the castellated tool and the cap removed with the utmost ease. When the valve cap is screwed home tight and has been in position for some time it requires very considerable force to remove it, and we were absolutely unable to stir those on our car till we had made this simple addition to the valve removing tool. This tip has been accepted by the makers of Wolseley cars, and all the later toolkits are provided with the holding-down bolt.

When removing hollow-shaped valve caps which have become too tightly fixed by corrosion or deposit to be shifted with a spanner or the special tool provided by the makers, I have found the following method effective: Start the engine and run it until warm, and then pour cold water into each valve cap. This tends to make the cap shrink as apart from the body o the cylinder casting, and so makes it a comparatively slack fit momentarily, or at any rate for a short while only.—R. T. D.

Leaky Valve Caps.

19 Many makers have a curious predilection for hollow-headed engine valve caps with notched edges. The weakness of these caps is that they are extraordinarily difficult to remove. The special spanners provided for the purpose have a habit of "lifting" as soon as force is applied, and as a consequence the owner who is afflicted with them dare not make his valve joints really tight. On the writer's car these caps were so awkward to remove that he was forced to rely either on the faced joint or on a copper-asbestos washer to maintain that tightness of compression which is the life of every petrol engine. Neither of these methods is permanent. In theory, the faced joint between two well-ground surfaces ought to be permanent; but in practice, the insistent gas sooner or later finds a cranny to emerge by, and oil stains reveal the fact. The washer joint is notoriously insecure; the washer will stand tightening when the car has been run 100 miles after the joint is made, and ere long will leak at a dozen different points. On other engines the writer employs fish glue smeared on to ground faces, and has found this absolutely permanent, showing no leak after 5,000 miles. The misfortune is that the joint has to be broken whenever the valves require grinding, and great force is needed to break it. Finally the hollow nick-edged caps were scrapped, and ordinary hexagonal-headed caps substituted. Even when jointed with fish glue these caps can easily be shifted with a big box spanner and a long tommy bar; there is no liability for this type of spanner to lift.

Another method of stopping leaky valve caps is that suggested by Mr. Maurice Gandy: To prevent the setting fast of the adjusting screws of radius and brake rods, screwed valve caps, and other stationary parts exposed to moisture or heat, the threads, both internal and external, should be lubricated with mercurial ointment, which should not be touched with the fingers. Formerly when the junk ring bolts

of marine pistons were screwed into the cast-iron head instead of gunmetal plugs, this dressing was applied to ensure their easy withdrawal in port.

Timing Ignition and Valves: Verifying French Flywheel Markings.

20 Some little time since a Welsh correspondent asked the following amongst other questions to which replies were given at the time: "I have bought pretty nearly every book and pamphlet on motors, and not one tells the

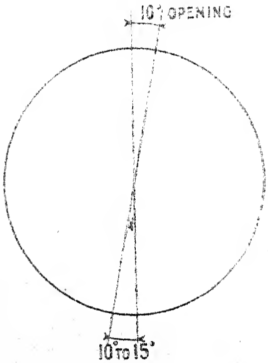


FIG. 1.

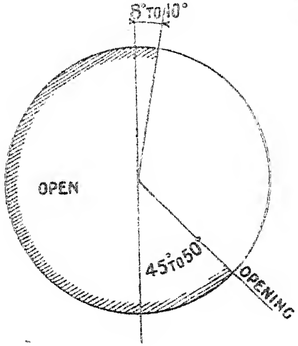


FIG. 2.

mystery of the marks on the French flywheels, and so the timing of the magneto tappets, which I understand somehow is affected or corrected by them. The marks I allude to are 1, 3, P, O, 3, 4, A, V, P, M, etc., etc. Do you know of any book giving the above information?"

Now it is a maxim with us that no stone shall be left unturned to assist our readers in matters and questions of this character, but though we hunted through all the French motor engineering books on our shelves, and inspected the flywheels of several makes of French cars, we could not arrive at anything that threw any light upon the subject. Then we had resource to Mr. C. R. Garrard, who, from long association, is particularly *au fait* with French methods.

He admitted at once that the flywheel lettering and marks conveyed little or nothing to him, but went on to suggest a means by which their meaning might be made

clear to our correspondent. First, make trials until one of the marks is in a vertical position when the piston of one of the cylinders is at the top of its stroke. Next take a strip of paper exactly equal in length to the circumference of the fly-wheel, and divide this strip into divisions or parts of 10°. This is easily done by folding the strip of paper into six, when each division will be equal to 60°. These divisions should then be divided each into six equal parts, when each part will be equal to 10°.

To time the ignition, the ignition control lever should be moved to the position of maximum advance, and the break of the igniter arms from the igniter plugs should take place at the same point in each cylinder, say 25°, before the piston reaches the top of its travel on its compression stroke.

It is vitally important that all the cylinders should be set with exactly the same amount of advance without touching the quadrant or altering the position through any lost motion there may be in the joints of the control rods.

While the paper is in position on the flywheel the timing of the inlet and exhaust valves should be verified. According to the latest practice the inlet valve should be timed according to the accompanying diagram, fig. 1. It should begin to open at about 10° past the top centre, and remain open from 10° to 15° past the bottom centre.

The general practice as to exhaust valves, as is shown in fig. 2, is to cause them to begin to open 45° to 50° before the bottom centre, and to close 8° to 10° past the top centre.

If the ignition and valve movements are found to coincide with the above directions, the engine is correctly timed, but if not, and the above instructions are carefully carried out, a marked improvement will assuredly be found in the running and pulling of the engine when it is next put to work on the road. In the course of carrying out this work it is probable that the French marks will declare themselves.

Deposit in the Exhaust Pipe.

21 When cleaning up a silencer, one should always examine the condition of the interior of the exhaust pipe, more especially at the end which is secured to the silencer, for very often at this end of the pipe a heavy deposit of burnt oil will be found, which in some cases restricts the area of the pipe as much as 15% or 20%. This is especially the case with those engines which have a tendency to smoke at the exhaust. The burnt oil issuing from the engine is, of course, deposited within the whole length of the exhaust branch

and pipe, but the interior of the former and of the latter near the engine is scavenged, one might say, by the subsequent clean exhaust issuing from the engine. The exhaust issues from the engine in the form of a flame, which burns away the deposit within the exhaust branch, but as the exhaust gases travel along the length of the pipe leading to the silencer they are naturally cooled, and the flame does not extend within the whole length, so that the burning effect is not present at the rear end of the pipe ; consequently, any deposit which is formed remains and rapidly accumulates to restrict the passage within the pipe.

A Cause of Blowing Exhaust Joints.

22 The following is a fault which sometimes develops owing to a choked silencer. A motorist is sometimes heard to complain that the exhaust pipe joint washers, which help to form the union between the exhaust branch on the engine and the exhaust pipe leading to the silencer, are continually blowing out. Of course, the most usual cause of this is the flanges of the joint not being parallel, or one or the other of them, perhaps both, being bent, so that the pull of the bolts merely compresses the washer at each end and leaves it unsupported at the most important point, viz., the centre, but a choked silencer will also tend to cause an exhaust joint washer to blow, for when the exhaust gases are throttled, as previously suggested, in passing through the silencer a considerable back pressure is set up within the exhaust branch and pipe. This back pressure may, and often does, have the effect of blowing the joint mentioned.

Touching the matter of exhaust joint washers, the efficiency of an engine is often reduced when a washer is renewed, owing to the diameter of the central hole being smaller than the interior diameter of the exhaust pipe. Of course, when a washer is cut from sheet asbestos, and the central hole is left smaller than it should be, the passage of the exhaust gases very soon blows away the surplus asbestos protruding within the pipe, but when the joint is formed with a copper-covered asbestos washer the restricted bore is likely to prevail for some considerable time—in fact, it may remain permanently.

Choked Silencers.

23 References are often made to the effect of choked silencers upon the efficiency of the engine as shown by the power it develops on the road, but it is often forgotten that a badly choked silencer is liable to have the effect of

causing overheating. This, of course, is only another symptom of inefficiency, but it is not always recognised as such, and those who have taken over cars which have been in use for some time, and regarding which they have no standard whereby to judge the efficiency, may be satisfied with the power developed, and yet considerably perturbed by persistent overheating. If this trouble be caused, as it often is, by a choked silencer, the removal of the cause will not only have the effect of stopping the overheating, but will add considerably to the power of the engine.

The effect of a choked silencer upon the engine is exactly the same as that caused by a short lift to the exhaust valve, for in both cases the exit of the exhaust gases is considerably throttled, and although the throttling effect in the one case is some distance from the engine, viz., in the silencer, the result as regards overheating and inefficiency of the engine is exactly the same.

In their efforts to obtain a quiet exhaust, many manufacturers employ a form of silencer which necessitates the passage of the exhaust gases through a number of small holes. It has been pointed out before that a considerable loss of power may be experienced owing to these small holes becoming choked by the burnt oil and other residues from the engine. The remedy for this loss of power is, of course, to take the silencer to pieces and clean the holes, but although the directions to obtain the desired end are very concise and occupy very few words, the time occupied in taking a silencer to pieces, cleaning, and refitting it, often amounts to hours; this is in consequence of the threads of the various screws and bolts holding the portions together having become burnt or rusted. Having experienced the necessity to clean these holes in the baffle plates of my silencer two or three times in the course of six months, I determined to enlarge them permanently by reamering them out, so that the necessity for cleaning the holes would not arise so often. I fully expected that the exhaust would be considerably more noisy, but at any rate, so far as the occupants of the car are concerned, no difference has been noticed, although a distinct improvement in the engine power has been apparent. It would appear that the silencers of some engines waste too much power to obtain a silent exhaust.—F. S.

How to Remove a Broken Screw.

24 In dismantling an engine sometimes a screw or stud will break off short, and difficulty will be experienced

in removing it. Generally there is not enough projecting metal to enable a good grip to be obtained with pliers, so that a saw cut has to be made in it for a screwdriver. If there is not even enough metal for this, a hole should be drilled vertically in the screw, and the triangular or rectangular tang of a file inserted, which will generally obtain sufficient hold to enable the screw to be removed. If a left-hand flat drill is used—that is, one cutting counter-clockwise—this alone will often be sufficient to bring out the screw. In extreme cases, an alternative is to drill a hole vertically in the screw as before, to tap the hole with a left-hand thread, and screw it in with a left-hand screw, which, on being screwed up tight, draws out the right-hand stud.

Nuts and Heat Expansion.

25 When tightening nuts on to bolts which hold any cast portion of the motor in position, great care should be taken, if there are more than one bolt holding the cast portions together, that the nuts are screwed equally. Each nut should be screwed down a little in turn, and not one tightened and then the other. It is also well to remember that most parts of the engine expand as soon as it heats, and that it is quite unnecessary to screw down every nut with a two-foot spanner. When a nut cannot be undone without the employment of undue force paraffin should be poured on it and it should be left for a few hours for the oil to soak into the threads. It should then unscrew easily.

Erratic Running at Low Speeds.

26 Many owners find, after they have had a car in use for twelve months or so, that the running of the engine at low speeds is very erratic, both when the car is stationary and when it is moving along the road. For instance, sometimes with the throttle lever on the wheel set at a particular point on the quadrant the engine will run at 400 revolutions per minute; at other times, with the lever on exactly the same spot, the engine will come to a standstill almost immediately. The cause of this want of uniform control is often the slackness which develops in the various joints and connections of the throttle. Between the hand lever and the actual throttle valve in the inlet pipe, some cars have as many as six or eight joints, and the slightest wear at each one of these will in the aggregate amount to a considerable movement at the throttle valve itself. Consequently by moving the lever a certain amount one is never sure that the throttle is not moved considerably more or considerably less.

The remedy is surely obvious: the slackness of the various joints and connections must be taken up. The same defect is sometimes existent in the ignition control, but with this the inconsistency is not nearly so noticeable. A slight risk is, however, attendant on slackness of ignition control joints, in that when starting the engine the safety point in the setting of the "advance" may be passed and a backfire may result.

Engine Efficiency in Cold Weather.

27 It is undoubtedly a fact that during the winter months, especially in frosty weather, many cars, in fact the majority of modern cars, run more efficiently when the fan belt is either removed or used very slack. In the cold weather the heat-dispersing properties of the radiator are really too efficient, with a consequence that the engine, during the whole of the time it is running with the fan belt normally tight, is kept far too cool for high efficiency. Even in the summer time it is noticed that an engine will pull far better when it has been running a short while, viz., when the water has become hot, but in many cars this stage is never arrived at in the winter owing to the effective draught of cold air drawn through the radiator.

Experiments with a view to bringing about an improvement in this direction should begin with a slackening of the fan belt, and so long as the water does not approach boiling point when the engine is hard driven, the slackening cannot be carried to excess. When it has been noticed that the engine keeps cool with the belt very slack, its entire removal can be tried, but this procedure is not advised as a start off. Another means of reducing the efficiency of the radiator in the manner desired during the winter months is to fix a sheet of cardboard or similar material at the back of the radiator, between it and the fan. This sheet of cardboard should have a hole cut in the centre of such a size that a comparatively small amount of air can pass through. For instance, the hole may be made 12in. to 15in. in diameter, so that the amount of air that can pass through would be considerably less than through the entire surface of the radiator, which might measure 24in. or 26in. across. When this baffle is fitted it is generally found advisable to keep the fan belt normally tight.

Knocking and Overheating Cured.

28 During the last two years I have been troubled with an intermittent knock in the engine of my car. When it occurred a great deal of the power seemed to be lost, and

hills which the car should take on fourth speed could only just be managed on second, and very often the water would boil as well. I will not say what I spent on the car before tracing the cause, but when I mention that I had a new carburetter fitted, a new magneto, and the car overhauled by the makers, it will be appreciated that I did not let the matter rest for the want of any reasonable expenditure.

Eventually the trouble was found to be due to two things. It was suggested to me that the occasional overheating was due to some loose impediment which occasionally blocked the water pipes, and upon removing the main water pipe from the pump I found this contained lumps of loose solder, apparently worked through from the radiator. This main pipe has four branches leading to the separate cylinders, and these branches are of considerably smaller bore than the main pipe, so that the solder was at times forced into the small branches, blocking one or more or restricting the water supply and causing the overheating. At times, I imagine, the solder would fall back into the main pipe, in the same way as a piece of foreign matter in a petrol jet will fall back into the larger bore and cause no restriction of the supply for a short period.

Prolonged trials showed that the overheating was cured. But not so the knock, which was as bad as ever, and the irregular running also continued. Further investigation indicated that the timing wheels and exhaust camshaft bearings had at some time been short of oil, for the camshaft bearing at the front end had apparently seized partially and torn badly, and this had had the effect of putting so much additional strain upon the keyway of the half-time wheel that it had stretched to an extent that allowed a great deal of slackness or backlash. Consequently the exhaust valves sometimes opened late and sometimes too early, at other times correctly—for the camshaft was not, strictly speaking, loose in the wheel, so it might have held any particular position for some time.

Fitting a new key and renewing the torn bearing has made the car as quiet as ever, and although the engine does not pull quite so well as at one time, this is no doubt due to the fact that I have in the course of my experiments upset the adjustment of the carburetter. A little tuning up will no doubt set this matter in order also.—R. B. S.

A Camshaft Difficulty.

29 I recently experienced a trouble, the like of which I have not heard of before, and an account of it should

help others who may at some time or other meet with similar symptoms. In the course of a long run the power of one cylinder was found to be gradually failing, and eventually ignition entirely ceased in this particular cylinder. All the usual remedies and examinations were made, but ignition, sparking plugs, valve springs and tappets, etc., were all in perfect order. In turning engine with one compression tap open at a time, number three cylinder apparently had two compression strokes in the usual cycle, viz., two revolutions of the crankshaft. This naturally caused a great deal of perplexity, until after many hours of examination it was accidentally noticed that both inlet and exhaust valves opened at the same time. More examinations followed, and finally the trouble was traced to the exhaust valve camshaft. In the engine in question the cams are not formed in one piece with the shaft, but each cam is secured to the shaft by a large taper pin passing through both cam and shaft. One of these pins had sheared, and allowed the cam to turn very gradually on the shaft. In turning thus it had torn the shaft somewhat, so that it became jammed firmly in an incorrect position, causing the exhaust valve to open at the same time as the inlet. The gradual falling off of power was no doubt occurring when the cam first came adrift, and began to work round the shaft, so affecting the timing of the valve more and more. This applies more particularly to old engines, as the majority of modern engines have the cams cut solid with the camshaft.—M. W. B.

Finding Dead Centres.

30 I wished to find the dead centre on an engine that had no compression taps and the plugs too much on one side to enable a wire to be pushed down to the pistons. I got an old sparking plug and fitted a small piece of tubing into the hole usually occupied by the central electrode. Over this tube I fitted a length of feeding bottle rubber tubing, and into the end of this I fitted a small piece of glass tubing drawn out to a fine point in a gas flame. On placing the end in a glass of water and turning the engine slowly (the plug, of course, being screwed into its place), as long as bubbles issued from the glass tube the piston was still rising, but the instant the dead centre was reached the bubbles ceased, and the slightest movement was sufficient to cause the water to begin to rise up the tube. This method gives the dead centre with great accuracy.—F. W. Beckford.

ENGINES.

Refitting Induction Pipes.

31 Motorists who look after their own cars should be most careful in replacing union washers. Two instances of neglecting to do this have been brought before the writer. In the first case a recently erected engine refused to fire. Everything was apparently in order, and yet nothing would persuade the engine to start. After much time, and after many things had been tried, it was found that a washer in the induction pipe union had been omitted. This omission allowed the mixture to be weakened too much, but on its replacement the engine started up at once and gave no further trouble. The second case was in dismounting a carburetter to clear out the jet and generally overhaul it. Apparently everything had been correctly assembled, and yet the engine altogether refused to fire. After many attempts to start, and several futile experiments, it was found that in remounting the carburetter a washer had been set crooked, completely blocking the inlet pipe.

Leaky Induction Pipes.

32 The following is a plan which I have found successful in the detection of leaks at induction pipe joints: Disconnect the fan by removing the fan belt, start the engine, and with a roll of brown paper smouldering, but not in flame, make a smoke test by holding the brown paper close to each joint in turn. If there be a leak at any one joint, the smoke will be noticeably drawn into the induction pipe at that point.—C. M.

Mysterious Knocks.

33 The engines of a car we were driving recently suddenly set up a sharp metallic knock, and all efforts to trace its cause were unsuccessful for a time. The car ran as well as ever, which rather enhanced the difficulty than otherwise, and by degrees we discovered that the knock existed whether the engine was running or not, provided the car was in motion. This was of great assistance, as previously the knock had kept time with the engine speed approximately, and appeared to be in the engine. Almost every separate portion of the car was dismantled by degrees, and yet the knock remained entirely unabated. At last a derisive acquaintance exclaimed, more in jest than in earnest, "You've looked everywhere except in the silencer." The involuntary hint was promptly acted upon, and, sure enough, the noise was traced to a loose baffle plate in the silencer, which hammered up and down in rough unison with the engine speed.

In another case a knock that sounded as though a big end was loose was in reality traced—but not without a good long search—to the flywheel bolts having stretched, the said flywheel being bolted to a flange.

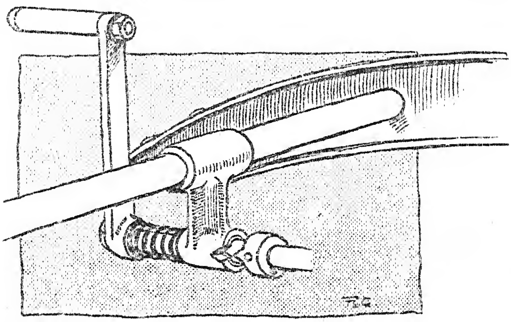
To Locate a Knock.

34 When the multi-cylinder engine develops a knock it is, of course, necessary to have the particular bearing which has worn, or become loose, adjusted as soon as possible. In theory, all the bearings should wear equally, and when an engine begins to knock it should be due to equal wear of all the big ends, gudgeon pins, and main bearings. This ideal state of affairs is, however, very rarely reached in practice. As a rule, knock is due to the looseness or wear of one bearing only, and in nine cases out of ten it is a big end bearing. It may also be said that a single knock is more serious than the whole engine gradually wearing loose. This general laxity will not show itself till after many thousands of miles, whereas looseness of a single bearing, if it occurs at all, is generally long before it should have occurred from ordinary wear and tear, and it is therefore usually due to a bearing having seized and melted out its white metal, or, what is still more dangerous, to the bolts holding the bearing shell together having loosened in some way, so that there is a risk of the big end coming adrift and thereby wrecking the engine. A very simple way of locating the knock is provided on engines which have a separate cut-out switch to each ignition plug. The plan is to run the engine with one cylinder cut out at a time, and to notice particularly what happens when the cut out cylinder is switched in again. If one particular big end or gudgeon pin is loose it will always be found that, when the plug is switched on again, the cylinder which has the loose bearing will take up its work with a knock. If the other three are all right they will pass from no firing to firing without any audible knock, but the bad cylinder will make more or less noise according to the looseness of the bearing within or under it as the case may be. The engine should be run fairly fast with the ignition a little advanced.

Loose Starting Handles.

35 A good deal of rattle and noise from the front of the car when passing over bumpy roads is sometimes due to the starting handle, and the more nearly silent a car is, the more noticeable this rattle may be. Some time since we had a car which was very quiet in the ordinary way, but

when running over a rough road there was an abominable racket from the front. The sound seemed to be fairly low down, and we thought it must be the cross coupling rod of the steering, but after investigation we found this was not the case, and we only stumbled on the real cause accidentally as follows: When running the engine on one occasion to make an experiment, we got it so that it was firing unevenly and with unusual vibration. This started up a clatter in front which was easily traced to the starting handle, this being carried in a bearing depending from a cross tube in front of the radiator. The matter was temporarily remedied by fitting a new bush to the bearing of the carrying eye, but this was not altogether successful, as the bearing was short, and before long gave out again. We therefore overcame the



trouble by fitting a V-toothed collar, which fitted into two V slots, as shown in the sketch. It will be seen that the principle of the thing is that of the wedge, as the slots are not cut at quite the same angle as the V's on the collar; consequently the spring which holds the lever out of engagement also keeps the teeth buried in the slots. Incidentally the arrangement has another advantage, inasmuch as it holds the handle vertically and well out of the dirt, but the main idea was to stop rattle.

Flat Fan Belts.

36 Any motor cyclist could teach car manufacturers a good deal about belt drive, but as many car makers are too haughty to learn, they continue, in some instances, to fit thin flat belts running over a pair of small pulleys. The plain hook fastener employed makes a stiff place in the belt, which forms a tangent to the small arc of the top pulley,

and consequently undergoes great strains, which cause the belt to break within a few hundred miles. If no adjustment be provided, the belt is then too short, and is useless. Inserting a spare piece merely doubles the stiff places by demanding an extra hook, and leads to more frequent stoppages with broken belts. Under these trying circumstances it is advisable to get a piece of really first-grade belting from a good mill-belting dealer; if the new belt be procured from the car factory, it will probably have the faults of the old belt, and during long residence in a pigeon-hole of the store room it may have lost all its natural lubricant. Stretch a new belt thoroughly by hanging it up for a week with a heavy weight attached, and rub into it as much castor oil or collan oil as it will absorb. Then bevel off the ends to a long gradual taper, and get a local saddler to stitch them together, inserting a few countersunk rivets as auxiliaries to the stitching. This belt should run for two or three years if it be occasionally dressed; and the long life amply repays the trouble of putting it on—a process which may demand the removal of the starting handle. In the millennium, fans will be driven by built-up V belts, attaining genuine flexibility by patented methods of construction, and devoid of any joint or stiff portion.—B. H. D.

Adjustment of Engine Bearings.

37 There are probably many amateur mechanics who would like to try their hand at taking up the bearings in their engines, and the following notes have been compiled with a view to making the task easier and the results more satisfactory:

All the parts of the engine having been dismantled and numbered, if this has not already been done by the makers, the first procedure is to examine the crankshaft, and if this is found to be scored, the marks must be taken out by means of a lap while the crank is slowly revolving in the lathe, or if a lathe be not at hand, by means of a dead smooth file and emery cloth. The lapping method certainly gives the best results, and should be used in preference to the emery cloth method if possible, as most crank pins wear out of truth, due to the greatest pressure continually having effect upon the

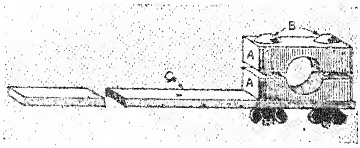


FIG. 1.—LAPPING TOOL. A, lead blocks. B, binding bolts. C, steel handle.

same spot on the pin. The lap will tend to true the pin up, whereas the emery cloth method will only smooth up the surface. A lap may be made as in fig. 1, where A A are lead blocks shaped as shown, B being small coach bolts securing the blocks to the flat handle C, and provided with wing nuts. The width of the lead blocks should only be about half that of the crank pin, so that it may be worked from side to side to prevent rings being formed on the surface of the pin. The lapping process may, in a measure, be likened to that of grinding in the valves of an engine, the valve seating being replaced by the crankshaft and the valve by the lapping tool. A mixture of fine emery powder and oil forms the lapping or grinding medium. The crankshaft should, correctly speaking,

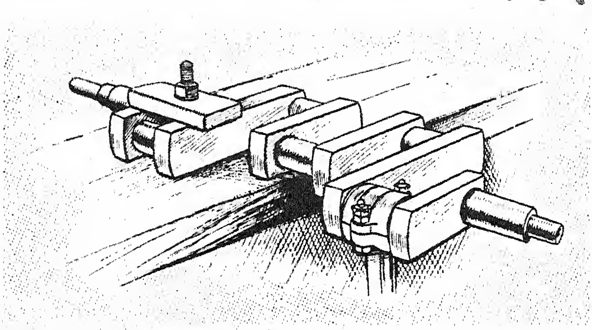


Fig. 2.

be mounted and revolved slowly in a lathe, and after fitting the lap to the crank pin to be operated upon, a liberal supply of mixture should be applied before and during the rotation of the crankshaft, the lapping tool being held by hand. As the lead blocks bed down, the wing nuts must be tightened to retain the necessary pressure, though nothing abnormal in this respect is necessary.

Lapping the Crank Pins.

It is, however, more than possible that a lathe will not be at hand. In such a case the crankshaft may be secured to the bench, as shown in fig. 2, and the lapping tool turned by hand when fitted to the crank pin in lieu of the connecting rod. It is essential that the side to side movement should be maintained with regularity in order that the process may have effect equally over the whole width of the surface. The lapping should be continued until a dead smooth surface is obtained.

Neither of these methods is, however, of much use if the crank be badly scored, through lack of lubrication or a "melt out" of a white metal bearing, for instance; in such cases it is advisable to have the shaft reground by a competent firm of engineers who possess the necessary grinding machines and fixtures for this class of work.

The crankshaft being true, it should for convenience be secured firmly to the bench—in preference to holding it in a vice—by means of a bolt provided with a plate of sufficient size to bridge two of the crank webs, and passing through the bench, as shown in fig. 2. The first crank pin to be operated upon should overhang the bench, so that it may be

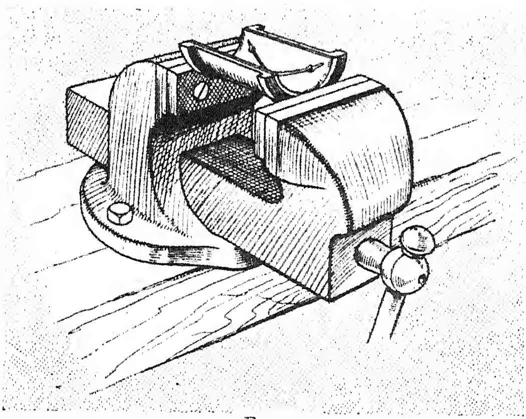


FIG. 3.

possible to work the connecting rod round when fitting the brasses; and in speaking of brasses white metal-lined bearings may be included.

If the amount of slackness in the brasses be but slight, it will be sufficient merely to rub their edges on a piece of emery cloth laid on a flat surface, such as a lathe bed or surface plate. This plan is better than using a file, as it will ensure the edges of the brasses being quite flat and without any tendency to rock when placed together.

Sufficient should be taken off the edges of the brasses to make them grip the crank tightly, the outer diameter being repeatedly checked by means of a pair of callipers during this operation to see that it remains parallel, otherwise the con-

necting rod cap will only grip the halves at one end, and, the support being insufficient, they will quickly work loose in the connecting rod end. When it is judged that enough has been taken off the edges of the brasses to allow of scraping in to fit the crank pin, the edges of the connecting rod and cap should be similarly reduced—but in this case a file must be used—being extremely careful after the latter operation to check the bore of the connecting rod and cap and see that parallelism is maintained, for it is just as essential as in the case of the outer diameter of the brasses.

Scraping Brasses.

After this the brasses should be assembled in position, and with the connecting rod bolted on to the crank pin—which should previously be lightly smeared with a little (very little) red lead mixed with oil to a stiff paste—then, taking care that the connecting rod is the right way round, if there

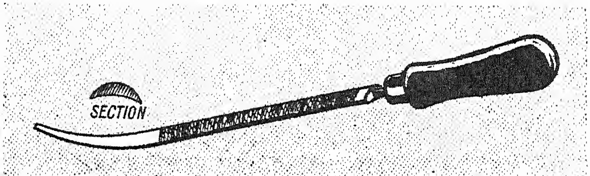


Fig. 4.

happen to be a long and short side to the big end, the rod should be worked round a few times and then removed; it will then be found that the high spots on the brasses are marked red. Holding each half brass in a vice in the manner illustrated in fig. 3, the high spots must be removed by means of a scraper. The most convenient shape of tool for this class of work is shown in fig. 4. Usually these are made out of an old half-round file, and should be hollow ground, as shown in the sectional view, and finally finished, and afterwards kept keen by rubbing on an ordinary carpenter's oil stone; to scrape properly the edge must be almost as keen as a razor. There is undoubtedly a knack in using a scraper, which can only be acquired after considerable practice, and it is advisable to practise on a piece of soft metal formed as one of the blocks of the lap shown in fig. 1. The operations of taking a little off the connecting rod, cap, and faces, bolting up to the crank pin, removing and scraping down the high

spots, must be repeated until the brasses mark up evenly all over after being turned round the crank pin when bolted in position, and at the same time their edges must have come tightly in contact, and also those of the connecting rod and cap.

To Guard Against Loose Bearing Bolts.

If the edges of the brasses do not touch when the bolts are tight, as at A in fig. 5, it can be understood that as the surfaces wear the brasses will become loose in the connecting rod big end; further, if the edges of the brasses meet, but a space be left between the connecting rod and cap, as at B in fig. 5, the comparative light edges of the brasses will give way under the strain of the big end bolts, and the pounding of the engine will result in the loosening of the cap after the engine has been run a short time. Another point to observe is to make sure that the heads of the big end bolts are bedding down solid in position and not riding on any fins, burrs, or dirt, which, flattening down after running, will allow the bolts to slacken off. To guard against this the bolt heads should be struck with a hammer a few times on finally screwing up; also it will be as well to give the connecting rod a good pounding with a mallet on the gudgeon pin end and on the cap to ensure the brasses themselves being thoroughly bedded into the connecting rod big end. If the gudgeon pin end of the connecting rod be struck with an ordinary or soft metal hammer instead of a mallet, consideration must be given to the thickness of metal left at that point by the bore, that is to say, do not strike so hard as to flatten out the small end of the rod. When the bedding in has been accomplished the brasses and crank pin should be well cleaned and then covered with oil before finally assembling, and also the oil grooves must be made their original depth by means of a small half-round bent chisel. As the amateur mechanic is rather prone to the use of spring washers, I would decry this practice on bearing bolts or cylinder flange studs, for they are apt to snap in two and fall away from the bolt, leaving it slack, and probably bringing about disastrous results. Well-fitting split pins tightly hammered over to

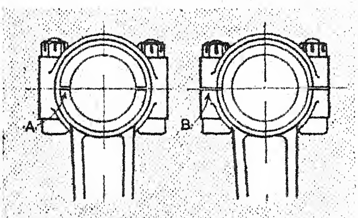


Fig. 5.

prevent their working and wearing in the holes and finally dropping out are alone permissible for securing the nuts of these bolts.

THE TIGHTNESS OF BEARING.

The tightness of the brasses on the crank pin must not be adjusted by means of the bolts; these should be drawn up as tightly as possible, and if the bearing then work too stiffly a little more should be scraped away from the bearing surface until they are a nice fit.

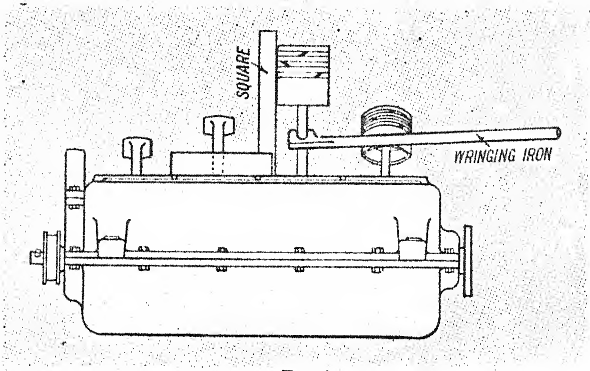


FIG. 6.

It is impossible to give directions as regards the tightness of a bearing; no hard and fast rule can be laid down, for this matter depends upon the thoroughness with which the scraping has been carried out. As a rough guide, it may be taken that if the connecting rod will just or hardly support itself horizontally when bolted to the crankshaft it will not be far wrong. White-metal brasses may be set up tighter than bronze, as, the metal being softer, any remaining high spots are soon levelled down with the running of the engine.

If possible, it is desirable to run the bearings in by belting the engine up to a line of shafting, but if this be not possible the engine should be run slowly for short intervals to give time for the brasses to cool down between each run. Never race an engine immediately after the bearings have been refitted, as the greater the speed the greater the heating—it serves no useful purpose, and only shows lack of mechanical knowledge, besides putting an enormous strain on all the parts of the engine; the same applies at any time for that matter.

After all the big end brasses have been fitted, these should be removed and placed at one side until the main bearings have been attended to. It will be found in some cases that the latter are in good order, as they do not, or should not, wear as rapidly as the big ends. It is, therefore, as well to try them for shake before spending time in refitting. The lubricating oil should be washed out with paraffin, for a long bearing having considerable shake in it may otherwise feel quite tight, owing to the presence of thick oil.

The Main Bearing.

If it be deemed advisable to take up the main bearings, the same procedure may be followed as with the big ends, only that in engines where the bottom half of the crank case also forms the bearing caps the brasses will require packing up with metal foil or paper, as the caps so formed cannot be let up to the brasses. While this method of packing up the brasses is permissible in the case of main bearings, it should never be resorted to in the case of big ends or trouble may result.

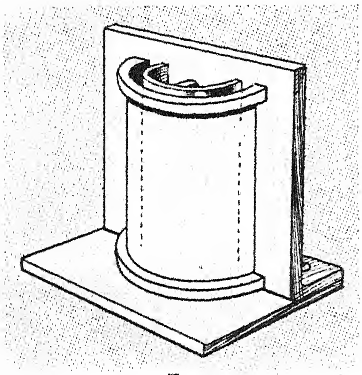


Fig. 7.

The top half of the crank case should be turned the reverse side up on a pair of trestles and the two end bearings fitted first; then, as each intermediate or single centre bearing is fitted, it should be noted that the crank does not ride on the brass or require springing down to bed properly. Want of care in this direction has been the cause of many crankshaft failures.

When the main and big ends are finally assembled absolute cleanliness is essential, as any foreign matter between the brass and the shaft will cause heating, and any dirt between the brass and its housing will crush and, working out, leave the brasses slack again. Everything having been assembled and the bottom half of the crank case fitted, the whole should be turned over and the pistons fitted. If the gudgeon pin bushes be worn they should be replaced, although another plan, when the pin has also worn slack in the piston, is to pass

a reamer of slightly larger size than the original pin through both the bush and the piston and fit a new and slightly larger gudgeon pin. Many of the engines of a year or two ago would be all the better for this treatment, as the pins were generally on the small side. Undoubtedly a number of pistons are distorted by the bending of the gudgeon pin, this being shown by the uneven wear apparent with some pistons.

As each piston is fitted it should be tested for squareness by means of a square placed against the side of it and on the top of the crank case, and if any one or more be incorrect in this respect the connecting rod may be sprung by means of a wringing iron, as shown in fig. 6. Many omit this little refinement; and though considerable variations should not be corrected in this way, it stands to reason that, as no special precautions are usually taken to keep the bore in the brasses parallel during the scraping-in process, the pistons are certain to be out of truth sometimes, and if the engine be assembled without this being rectified, the big end bearings will wear bell-mouthed. This point may be checked earlier, in the process of scraping-in the bearings, by temporarily fitting each connecting rod, the crankshaft, and piston together and squaring up to the crank cheeks.

Remetalling of White-metal Bearings.

In engines which are fitted with white-metal bearings, it occasionally becomes necessary to remetal one of these or the whole set. There are a few tips in the remetalling of a brass, the knowledge of which will save a lot of time and ensure satisfaction. Many fail in a simple job of this nature through trying to accomplish it in too makeshift a way. A simple jig, as shown in fig. 7, will enable a white-metal to be cast in a brass ready for scraping-in to the crank without boring out. The half-section of a piece of steel cycle tube the same size as the crank pin should be riveted to the sheet-iron angle plate quite square with the base, the half brass being held by a clip or bound to this with iron wire. The crevices round the brass and the jig should be filled up with fire clay. The jig must be constructed wholly of metal, so that the whole may be heated up with a blow lamp to almost the melting point of the white metal. The old metal having been melted out and the half brass having been well tinned (covered with solder and then wiped with a cloth while the solder is in a molten state) before being fixed to the jig, the white-metal should be melted in a clean plumber's ladle and poured in between the jig and the brass. (Care must be taken

not to overheat the metal or its nature may be altered, owing to some of the constituent parts being volatilised.) While this is being done it is advisable to keep the metal in the ladle stirred, as some brands of alloy require this to prevent the metals of which they are composed from separating, which would result in hard and soft places in the finished bearing. If any blow-holes occur on the surface of the bearing, these may be filled with white-metal run in with the aid of a blow-lamp or soldering-iron to save recasting.— W. BOURNE DALE.

Overheated Bearings.

38 When the main bearings and big end of the connecting rod bearings are scraped-in when new or after running some considerable time it is necessary to take up the wear and rescrape the bearings after a greater or less period. On again running the motor, it is sometimes found that there is a tendency to overheat the bearings, and liberal supplies of oil must be given to avoid seizing. It will be found that if after scraping in the brass, and before putting on lubricating oil, the wearing surfaces are well rubbed with flaked graphite, they will run much sweeter and will not have the same tendency to heat up. When examined under a microscope the surfaces appear to be porous, and made up of more or less sharp crystals. The effect of the graphite appears to be that the pores are filled up with this unctuous material and a smooth surface formed, friction thus being materially reduced. Be sure that pure flaked graphite only is used.

Dirty Engines.

39 From time to time one comes across or hears of an engine which has developed a mysterious knock, and for which neither advanced ignition nor worn bearings can be accounted responsible. It is well, therefore, to point out that a very frequent cause of an engine knock is the formation of carbon deposit in the cylinder head and on top of the piston. This carbon deposit (which becomes incandescent, and so causes pre-ignition) is formed partly of the residues of combustion, but is made up mostly of burnt lubricating oil. In many cases the excess of carbon deposit is brought about by excessive lubrication, but on the other hand some engines are naturally prone to the formation of this deposit, and no amount of care in regulating the oil supply correctly will prevent it.

There are several chemical carbon removers on the market, and recently a process has been introduced by means of which

the carbon can be removed by burning it out through the agency of oxygen. The more usual method is to remove the cylinders and scrape away the deposit from piston and combustion head, but by means of specially formed scrapers (which can be made from pieces of wire or steel strip specially for the engine on which they are to be used) it is possible to remove the deposit without taking off the cylinders. Of course, the work cannot be so thoroughly and certainly done by this method, but where a knock has become very bad and there is not time to take the engine down the cause of the trouble can frequently be removed by an hour or so's work with scrapers manipulated through the valve pockets. When this method is adopted the piston of the cylinder to be operated upon should be brought to the top of its movement, both valves being closed. After the deposit has been loosened it should be removed from the cylinder by any means available, such as blowing into one valve pocket with a pair of bellows, allowing the chippings to fly out through the other pocket, or it can often be removed with a piece of flannel moistened with paraffin, to which the scrapings will stick if the rag be pushed well inside the cylinder with a piece of wire. There is no doubt that not only will carbon deposit cause a more or less serious knock, but in many cases it also causes loss of power by restricting the valve passages and consequently the flow of the gas, both inlet and exhaust.

Internal Cleaning of Slide Valve Engines.

40 Owners of slide valve engines who have not had previous experience with the type should bear in mind that the operation of cleaning is an entirely different one from that of cleaning a poppet valve engine. The cylinder heads of the slide valve engines are detachable and quite easily removed by the undoing of half a dozen nuts which hold the head down. Sometimes the head sticks a little, but it can be immediately removed by turning the engine over, when the pressure of air compressed by the piston will push the head up—of course, the nuts should be left on so that the head will not be blown right off. In cleaning the engine it should be borne in mind that nothing need be done except to scrape the top of the piston and the inside of the cylinder head. The piston of each cylinder should be brought up to a position in the sleeve so that both the valve ports are closed. It should then be scraped in the ordinary way and the deposit carefully removed; it can easily be mopped out with a rag damped in paraffin. The valves should be

left severely alone, as any slight deposit which may have accumulated is a benefit rather than otherwise.

On each of the heads there is a two-piece junk ring and three ordinary piston rings, the junk ring being pegged for position, and in some cases the piston ring also. These rings should not be cleaned unless they are sticky, that is, not free; if they are merely dirty it does not matter so long as they are free. If it be necessary to clean them they should be thoroughly washed with paraffin and then oiled with engine oil. Before putting a head back into position the engine should be turned so that the inner sleeve is at its uppermost position. As a rule, the junk ring and piston rings slip in quite easily; if they do not, no force should be used, but a piece of wire taken and held tightly round each ring while the head is pushed down firmly. Any difficulty of inserting the rings into the sleeve is due to the fact that in some cases the sleeves are not so much tapered at the mouth as in the later engines, and the rings were stronger than those now used, as it has been found that there is no need for stiff rings to preserve a gas-tight working joint. With the later engines the rings slip in without the least difficulty, and there is no need to use a piece of wire to compress them. Of course, the rings should be arranged to break joint, though it does not appear to signify in the least if they all get into line, as the compression is not sensibly affected.

It is necessary to bear in mind with sliding sleeve valves that it does not really matter how dirty the engine is so long as the deposit is not sufficient to cause pre-ignition or knocking. Certainly they reach this stage no sooner than ordinary engines, but until the knocking occurs they are best left alone. This is due to the fact that any very slight leakage which may exist between the sleeves, or between the inner sleeve and the rings in the head, is filled up by the carbon deposit, so that the engine automatically increases compression after running a few hundred miles. As that is so, it is best not to disturb any of the deposit except that on the piston top and the inside of the combustion head. There is no real harm done in disturbing it except that it will take two or three hundred miles running, perhaps more, before the engine resumes its normal sweetness. We believe this is a point which has not been mentioned previously in print, and we mention it because the natural tendency of anyone who looks after his engine carefully is to remove every speck of carbon deposit away from everything he can get at when he cleans out a poppet valve engine. He does not realise that the valves as

such do not get dirty, and this is where the slide valve differs from the poppet valve, and explains why, short of pre-ignition, the normal condition of an internal combustion engine—dirtiness—is no drawback to a slide valve engine; indeed, within the limits we have named, it is an advantage.

To Make Cylinder Washers.

41 When an engine is taken down for removing carbon deposit, any washers between cylinders and crank case are likely to be destroyed; spares are probably not available, and the owner or mechanic has to wait till one arrives or to set about making one. It is a simple job to dump the cylinder on a sheet of paper and set to work with scissors and pencil in the case of single-cylinders, but a four-cylinder monobloc casting or a Ford combustion head washer is a very different proposition. Here is a common engineering shop dodge for rapidly producing a perfect washer: Stretch a sheet of thick brown paper taut over the cylinder base plate, or whatever part needs a washer, and tap the taut paper lightly with a very small hammer all round the outlines of the part that needs packing. The light blows will cut the paper against the metal, and a perfect washer, including accurately shaped and registered bolt holes, can be tapped out in a very few minutes. I made a paper template for a Ford combustion head washer inside ten minutes by this dodge, and afterwards transferred it quickly to a thicker material.—D.

Removing the Engine from the Frame.

42 First disconnect all wires, ignition rods, inlet, exhaust, and water connections, also the pump when it is removable and attached to the engine case, or any other bracket which prevents the ready removal of the engine. Always mark all the parts with a centre-punch, letter, or number stamps to facilitate reassembling; note the length of any adjustable rods, so that there will be no alteration in these when again put in place. Mark with a sharp scriber the exact position of the engine brackets on their bedding, in case the securing bolts are slack.

The next operation is to take off the cylinders: Slack off the nuts which secure the first cylinder flange to the crank case, then gently lift the cylinder until the piston can be seen. Rotate the flywheel until the piston comes to its lowest point, so that there is not far to pull up the cylinder. Allow the connecting rod to rest on one side of the crank case, so that when the cylinder is pulled entirely away from the piston

the latter will not fall against the rod and have a piece knocked out of it.

Having removed the cylinder or cylinders from the crank chamber and disconnected practically everything that can be disconnected, the pistons, which will be projecting out of the crank case, should be bound up in some rags, so that they cannot flop about and damage themselves or the edges of the holes through which they protrude on the connecting rods. A small single-cylinder engine can usually be removed with the help of a single assistant, but most engines are too heavy to take out of the frame, even when all the top hamper has been removed, without some form of lifting tackle. Very few private motor houses have any such facilities, and the only thing to do is to rig up a temporary crane. This can usually be arranged with the help of the local builder. From him a couple of tall trestles and a strong cross beam should be borrowed. From the centre of this a pulley and a chain or rope can be suspended, and after carefully fitting a couple of ropes round the engine, it can be gently hauled out by the tackle. Very great care must be taken in this operation, as the engine may swing about and damage itself or some part of the car. Of course, it is assumed that, before any attempt is made to lift the crank chamber, the radiator will have been removed, and in some cases the dashboard must also be taken away. In small motor houses there may not be room for a couple of trestles, and in that case the help of a carpenter will be necessary to fit up flat against the wall a couple of equivalents to trestles.

Having lifted the engine sufficiently high, the chassis can be run back, when the engine can be lowered on to a strong box or bench or on whatever it is proposed to keep it while it is being seen to. After the bolts holding down the engine to the chassis have been taken out, a very sharp look out should be kept for packing, as a good many engines are lined up in the frames by placing thin pieces of metal under the bearer brackets. These may vary in thickness or number, so that a careful note should be kept of the plates removed and the position from which they are taken in order that when the engine is put back it will be lineable with the chassis and the clutchshaft.

Starting a very Reluctant Engine.

43 I recently witnessed four men trying to start a particularly sulky 40 h.p. engine of semi-racing design. The theoretic plan is, of course, to discover why the engine does

not start at the first pull and remedy the derangement. In practice, these four experts failed as a single-handed amateur often fails—the quiet corners of our roads witness many desperate scenes. At last the quartette bodily pushed the car some distance to the summit of a hill, and started the car, and thus the engine, by gravity. Climbing the next ascent, the driver muddled a gear change, and contrived to stop his engine once more. A little later the party were attempting to make a bargain with the owner of a horse and cart, when the quiet amateur stole up and suggested placing sixpenny bits between each valve and its tappet, thus attaching an emergency half-compression valve. No sooner said than done. The handle, which had just previously caused four strong men to stand aloof, could now be revolved by a girl, and the engine started up at once. Testing being thus simplified, the derangement was soon traced and remedied, and the car sped on its way.—B. H. D.

To Start up an Engine after Standing for a Long Time.

44 In the case of an engine that has been standing unworked for a long time, it frequently happens that the motor is found to turn with great difficulty, and that there is little or no compression. In such cases some people are in the habit of introducing petrol to the cylinders by means of the compression taps or the sparking plug orifices. Occasionally these measures succeed, but not often. When they fail they only aggravate the evil. For my own part I have always advised injecting engine oil into the cylinders or a mixture of half cylinder oil and half paraffin. The root of the trouble is the fact that during the long stationary period nearly all the oil has flowed down the cylinder walls back into the crank chamber, while what remains, having become oxidised, no longer presents any lubricating qualities. Those portions of the pistons which are consequently devoid of oil are dry, and the metal surfaces are directly in contact with each other, thus on the compression stroke the gas can leak by.

The suction on the carburetter, though the latter be the best of its kind, is consequently relatively weak, and a very poor mixture finds its way into the cylinder. When petrol is introduced into the cylinders the four explosions resulting are sometimes sufficient to start up the engine and raise some oil on to the cylinder walls, but it frequently happens that the explosions so induced are too weak actually to start the engine, the exploded gases passing down the walls of the

cylinders past the pistons for the reasons given above. The petrol so introduced having dried up what little oil remained in position, the engine becomes harder to start than ever.

On the contrary, the thinned engine oil will flow between and round the piston rings and form a good gas seal at once; it will disperse the old dried oil or liquefy it and so render it useful; the engine will answer sweetly to the handle; a good suction will be exerted on the carburetter; a good mixture will result, and the engine will start merrily. It must be understood, however, that this happy result will only ensue when the engine is furnished with a good carburetter which will permit easy starting up when cold under ordinary circumstances. If, however, the carburetter is known to be stubborn under such circumstances the thinned oil treatment must be followed and the engine turned round by hand until it turns with its wonted sweetness. Then petrol, sufficient to compensate for the shortcomings of the carburetter, may be introduced through the compression taps or otherwise, but not enough to disperse the oil. Indeed, it is almost best under these circumstances to squirt the petrol into the induction pipe close up to the valves rather than into the cylinders themselves.—H. Feron.

A Case of Obstinate Starting.

45 The engine of a very well kept car under our notice had been gradually growing more difficult to start for some time past, and finally a solution was rendered urgent by its refusal to start under any circumstances unless petrol was first injected through the compression taps. It is a car on which the petrol consumption has been cut down to the vanishing point by a very ingenious and careful owner, and the fault was at length traced to the throttle spindle. The carburetter is an old pattern, and the throttle is a hinged disc threaded on a spindle revolving in two holes cut in the sides of the induction pipe. By long usage these holes had become slightly enlarged, and were admitting a considerable quantity of air. The jet having been reduced to the minimum aperture, the trouble was that, owing to the unsuspected ingress of this extra air, a sufficiently rich mixture for the engine to start upon had ceased to become obtainable. A new throttle of more up-to-date type was fitted as a cure. Difficulty in starting is often caused by an air leak.

Priming with Petrol.

46 It is a common practice with all engines which may be difficult to start to inject a little petrol into

each of the cylinders, as this performs the double office of providing an explosive mixture and also of freeing the piston rings, which may have become somewhat gummed after standing for a few days. A good many engines, however, have no compression taps, so that petrol cannot be injected in this way, but it often happens that these engines have automatic carburetters—that is, carburetters with spring-controlled air valves—and it is common practice to pour petrol into the air valve, as this is close to the engine, and the engine will suck petrol from here when it will not pull petrol through the jet. This is all very well, but one precaution should be observed on engines which have the magneto on the same side as the extra air valve. Should any petrol be spilled when pouring it into the air valve, the magneto, as soon as the spark is obtained, is almost sure to ignite the fumes, so that if there be the least risk of any petrol falling on or near the magneto when priming the air valve it is desirable that a cloth should be thrown over the magneto during the operation to serve as a protection.

LUBRICATION.

Care of Grease Lubricators.—Leaky Grease Lubricators.—Covers for Greasers.—Leaky Hubs.—Squeaks.—A Lubricant for Springs.—Keeping Oil Holes free from Dirt.—An Oil Force Pump.—The Smell from Cars.—Denaturised Engine Oil.—Cleaning Gear Boxes and Back Axles.—Keeping to One Brand of Oil.

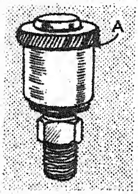
Care of Grease Lubricators.

47 Pressure should always be kept on screw-down feed lubricators serving grease on to the bearings. Owners should get into the habit of giving the caps of the lubricators an eighth, quarter, or half-turn frequently. Overmuch is vastly better than too little lubrication in such bearings as are so served.

It is often noticeable that the ordinary screw-down lubricator is very hard to manipulate. This is due to the feed hole at the bottom of the lubricator being too small, or to the lead pipe communicating with the bearings having too small a bore. There is no reason why screw-down lubricators should be made so difficult to operate; this matter really deserves more attention from the manufacturers and those who have to use them. The screw portion should be capable of being easily twisted round by means of the thumb and forefinger, and not have to be forced down with the hardest stress which can be put on with the hand or with a spanner

Leaky Grease Lubricators.

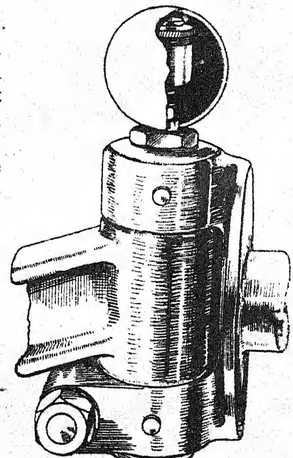
48 Although most of the best makers do not practise false economy, others, who should know better and who may make really excellent cars, give their customers considerable trouble by fitting cheap and too often nasty ignition plugs and grease lubricators. It is to the grease lubricators we particularly wish to refer at the moment. The cheaper ones, instead of being turned from the solid bar, are made in two parts, the cap and the barrel being separately made, and the consequence is that they very frequently leak round the joint, as indicated by A. The result is that when they are screwed up, the grease, instead of going to the bearing, oozes out all round the cap. At first sight it seems a hopeless job



to stop this except with a new lubricator, but we have found that, by carefully cutting a stout leather washer which fits somewhat tightly into the barrel, the trouble may be got over and the leak stopped. The best way to cut the washer is to place the lubricator upon the leather and tap it with a hammer so that an impression of the barrel is made on the leather, which should then be carefully cut, though, as we have said, to be successful the leather disc must fit tightly into the head of the barrel.

Covers for Greasers.

49 We once saw a very good tip for keeping screw-down greasers free from the dust and dirt which usually accumulate round these fittings, and some of which, unless carefully removed, is liable to get into the greaser, and so into the bearing, to its ultimate damage. The protector consisted of an ordinary indiarubber ball having a hole cut into it which would just allow it to pass over the greaser and get a grip on the collar or nut at the base. The ball covers were painted to match the car, and looked very neat indeed. With flap-top oil lubricators, such as those of the steering pivots, a protection of this sort is most desirable.



Leaky Hubs.

50 From time to time it will be found that the wheel bearings, and especially those of the front wheels, commence to throw out their lubricant. We are referring now to those bearings which are grease-lubricated. Of course, all bearings will do this if they are over-charged, but the particular leakage we refer to occurs when, perhaps, no grease has been put in the hubs for three or four hundred miles, and it does not necessarily happen on a very hot day. In other words, the symptoms are those of an overfilled hub, and yet one may know perfectly well that this cannot be the cause. When this is the case, the leakage is actually an indication that more

grease is required. What happens is this. Almost all greases subjected to a churning action, such as they get in a front wheel with its stationary pin and revolving hub, liquefy gradually, and after a time become so thin that the grease runs out of the hub like oil. The way to stop the leakage is to take off the hub caps, drain out the thin grease in them, and replace it with fresh grease.

Squeaks.

51 Failure of lubrication in any part of a motor and car is usually announced by a squeak, which may or may not be a matter of serious consequence. The motorist should always endeavour to locate the squeak at the earliest possible moment, and the first point to note is whether the squeak appears to keep rhythm with the engine or with any portion of the gear, or whether it be an intermittent squeak without any particular period of frequency. One point is worthy of remark—that a sparking plug will occasionally develop a leakage round the wire or at the joint, which will give a squeak very similar to a squeak due to want of lubrication. Should this be suspected, the sparking plugs may be changed or new copper washers fitted.

A Lubricant for Springs.

52 A good and lasting anti-rust lubricant for the leaves of axle springs may be made by heating and blending 1 lb. old indiarubber, ½ lb. grease, and ½ lb. graphite.

Keeping Oil Holes Free from Dirt.

53 Most users of cars are very neglectful in their oiling of short shafts such as brakeshafts, clutchshafts, and the like. They simply think that these parts can be left to take care of themselves, whereas they should be lubricated as regularly, although not so frequently, as the gear box bearing or road wheel bearings. As a number of brake spindles are carried on cast bosses which readily lend themselves to the fitting of clip rings over the oil holes, these clip rings, such as are usually fitted to the hub of a bicycle wheel, should be fitted over the oilholes, and thus no dirt or wet can be allowed to get in the shaft bearings. The brakes work much sweeter, and also clutchshafts have less friction, so that less effort is required to depress the clutch or apply the foot brake. On one occasion we came across a case of a rear brakeshaft which was absolutely rusted solid in its place, and could not be moved at all ; thus the rear brakes were rendered quite useless through a simple case of neglect of fitting these clips and of oiling the parts regularly.

An Oil Force Pump.

54 It is a great convenience to have a force pump for oil on the car. A thoroughly good one can be bought for 4s. or 5s., some 7in. or 8in. long, and really well constructed. With this the very thickest of oil can be picked up and injected into almost any part of the car. It is most useful for lubricating many places, and comes in handily in a number of ways.

The Smell from Cars.

55 There is no need for us to dwell upon the evils of over-lubrication so far as smoke and smell are concerned, but there are some cars which, whether they be over-lubricated or not, always smell more or less, and it will be found that this smell is different from the ordinary odour of burnt lubricating oil. In most cases it is due to oil or grease leaking from the gear box and thrown by the shaft on to the hot exhaust pipe. At this point the pipe may not be hot enough to really burn the oil up immediately, but it gradually fries it, and makes a most unpleasant odour in so doing. The remedy is a simple and obvious one. As a rule, the leakage, it round the primary shaft of the gear box bearing, cannot be stopped, and the thing to do is to protect the exhaust pipe from the splashes. This can always be done by fitting a thin sheet iron shield an inch or two from the exhaust pipe and between it and the line of the oil splashes.

Denaturised Engine Oil.

56 The average motorist pays particular attention to his petrol and oil—literally the breath and blood of the engine—but why should he wait till the engine virtually screams for attention in the matter of cleaning? This leads up to another point. One engine we have in mind has its crank case thoroughly drained every 900-1,000 miles and well washed out with paraffin, then refilled with oil. This proceeding seems absolutely necessary in these days of high-speed engines, and is a most important factor in the keeping of a clean, efficient engine.

Oil after being churned around in a crank case for 1,000 miles is, to use an Irishism, not oil at all; its "body" has gone. To boast that one's engine uses only a gallon of oil every so many hundreds or thousands of miles or so, thereby implying economical running in this respect, is positively foolish, for the pouring of fresh oil into the crank case without getting rid of the old oil is only lessening the lubricating properties

and increasing the carbonising proclivities of the whole ; besides which, surely oil is cheap enough.

Not only so, but the oil gets dirty from the dust which finds its way into the crank chamber and from minute particles worn off the bearings and cylinder walls.

Cleaning Gear Boxes and Back Axles.

57 We have mentioned in the preceding paragraph that a good many motorists do not sufficiently often empty out and clean their crank chambers, but those who give attention to this matter are comparatively numerous compared with those who never think about doing anything more to the gear box or back axle than refilling it from time to time with lubricant. The gear box is not like an engine, and it does not require emptying so frequently, but at least every six months the plug at the bottom of the gear box should be taken out and all the grease and oil in the box washed out with paraffin. The quickest way to do this is to take the lid off the gear box, fill it up with paraffin, then run the engine for a minute, so that the paraffin mixes up with the lubricant in the box sufficiently to reduce its consistency to a more fluid state, so that when the plug is unscrewed at the bottom of the gear box the mixture will run out freely. When it is run out the plug should be put back and the gear box half filled up again with paraffin, and all the stale grease should be brushed out of the corners and crevices with an old paint brush. The dirty paraffin can then be run out and the gear box filled with fresh lubricant. Some gear boxes are made to take oil only, but many still require a mixture of oil and grease, which should be of about the consistency of treacle. If it is much thicker it will simply pile up in the corners, after the toothed wheels have cut a track through it, and never be of any use till the bearings have become heated sufficiently to melt it, when the chances are that they will be damaged more or less seriously. If, on the other hand, oil only is used, in the average gear box it runs out round the bearings almost as quickly as it is put in. In fact, we have always experimented with every gear we have had so as to use the thinnest possible mixture—that is to say, the minimum amount of grease—but only in one or two cases have we found it possible to use oil alone without undue leakage. Half yearly, too, the back axle should be treated in the same way as the gear box.

Back Axles.

It will be found that all back axle cases have a screw plug at the bottom of the differential case, so that the pro-

cedure of swilling with paraffin can be carried out in precisely the same way, but it is, of course, best to jack the wheels up and turn them round by hand a few times to stir up the paraffin and the oil before letting out the mixture. As a rule back axles want no grease, and a good thick oil is all that is required, and it is much better to put in a little and often than to put in a large dose at one time, as the oil works its way along the axles and then back along the wheel hub out on the brake drums, whence it splashes the tyres on the insides badly. However, many back axle cases have no means by which the user can tell whether he has put in sufficient oil—and a careful man likes to be on the safe side—so the only thing to do is to put in enough, and then, if it comes out on to the tyres, to let out a little through the screw plug. Very few back axles require more than about two pints of oil, so far as our experience goes. All makers will inform the owner, on application, how much oil and grease should be applied to the gear box and back axle.

Keeping to One Brand of Oil.

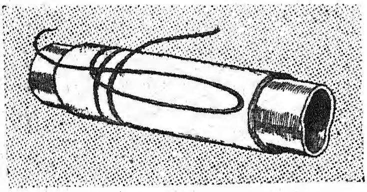
58 A man is often told to choose one brand of tobacco and keep to it. It is equally good advcie to recommend readers to use one brand of good oil and always employ it. This advice is certainly worth following when touring on the Continent, as many of the samples sold as oil are weird and wonderful. Three two-quart tins take up a great deal of room in the car locker, so it is advisable to fit an extra tank inside the bonnet if there be room enough, and there often is. Cars which are mechanically lubricated need no more attention than keeping the oil up to the required level in the sump, and it is far more convenient to maintain this level by turning on a tap from a reservoir than by pouring in the oil from a can.

WATER COOLING.

WATER JOINTS.—REMOVING WATER FROM RADIATORS.—STEAM PRESSURE IN RADIATORS.—CHOKED RADIATOR VENTS.—THE RADIATOR OVERFLOW PIPE.—REPAIRING CRACKED WATER JACKETS.—THE BEST PACKING.—FROZEN WATER JACKETS.—FROZEN WATER PUMPS.—BREAKING OF WATER PIPES.—LEAKY HONEYCOMB RADIATORS.—TO STOP SLIGHT LEAKS IN HONEYCOMB RADIATORS.—BRAN FOR LEAKY RADIATORS.—A TEMPORARY RADIATOR.—FAN BELTS FOR GROOVED PULLEYS.—THE FAN IN COLD WEATHER.—CLEARING WATER SYSTEMS.—FOULING RADIATORS.—A USEFUL WATER STRAINER.—STEAMING AT THE RADIATOR.—REMOVING FUR DEPOSIT.

Water Joints.

59 When a clip is too large to tighten up properly on rubber water connections, a few turns of insulating tape wrapped round the tube to enlarge it is a ready way of making the clip hold. A good substitute for a clip, and one that makes a sound job, is to bind the tube with black macrame twine, such as is used for fancy mats, fringes, etc. It is better than wire, and when wound on neatly and secured without a knot by underlaying the end, looks well. To serve it



on, take about five feet, double it as a hairpin about six inches from one end, and lay it on the tube. Take the first round turn over all about two inches from the bend, and draw taut, following with as many more turns as may be required, and working towards the loop, as shown in the sketch, but keeping the turns close together. Then pass the long end through the bend or loop, pull on the short end to draw the bight well under the turns, and then cut off the ends close.

Removing Water from Radiators.

60 Even at the present time there are radiators made which have no let-off water tap or plug fitted, and when it is necessary to drain them some water pipe connection has

to be broken. A great number of vertical tube gilled type radiators are in use, and in this pattern it is an easy matter to remove the whole of the water from the radiator when a let-off tap or plug is not fitted.

If a small piece of rubber tube be dropped down one of the vertical tubes of the radiator until it reach the bottom part of the tank, and a piece be left dangling down outside the radiator, the length being long enough to reach below the level of the bottom of the tank, a suck at the end of the outside portion of tube will start the water syphoning over, and if left to itself the water will be all drained from the radiator. This method cannot be employed for honeycomb radiators, as the tubes are too close together to allow the rubber pipe to pass between them.

Steam Pressure in Radiators.

61 Radiators which are apt to steam freely on long climbs, *e.g.*, over Scotch mountain passes, will be relieved of internal steam if the cap be removed and a piece of rag tied over the filling orifice before attempting really colossal ascents.

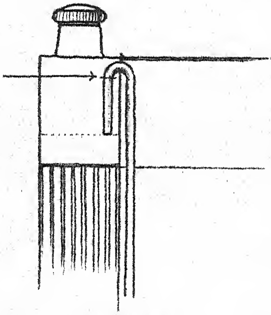
Choked Radiator Vents.

62 In replenishing the radiator it is always advisable to fill it slightly above the vent or overflow, so that one can assure oneself that the vent pipe is not choked. If the vent pipe be allowed to become completely blocked, it is bad for most radiators, as an accumulation of steam, which is very general when climbing long hills on hot days, fills the radiator, and puts a certain pressure above atmosphere upon it, so that if there are any weak places the radiator is certain to commence to leak. It would hardly seem probable that the vent pipe should choke sufficiently to permit any pressure to be generated in the radiator, but the fact remains that these vent pipes do choke in this way if they are neglected, as a certain amount of sediment gets into them from the water, and that, combined with grit, seems to make a sort of plug of hard, almost cement-like nature, which completely seals the vent. So many radiators are more or less delicate that the matter is well worth bearing in mind.

The Radiator Overflow Pipe.

63 A casual acquaintance who owns a car was much perturbed owing to the fact that, after five or six miles running with a normally filled radiator, a large quantity of water issued from the overflow pipe of the radiator. This was put down to overheating, and to prevent trouble from

this cause the water lost in the manner described was immediately replaced by the radiator being filled up once more. The true cause of this peculiarity was not, however, overheating, but was due to the shape of the continuation of the overflow pipe within the radiator, where it extended downward for some five or six inches. After running a few miles, starting with a cool radiator, the warming of the water causes it to expand, and the excess would as usual find exit by way of the overflow pipe; but, owing to the inside end of this pipe being considerably below the level of the water, the slightest quantity overflowing would set up a syphoning effect, and this would be continued until the water within the radiator had fallen below the level of the interior end of the overflow pipe. The remedy, of course, was to remove the surplus length of pipe inside the radiator.—B



Repairing Cracked Water Jackets.

64 To stop fine cracks or fissures in the water jacket of a cylinder, dismount the cylinder or cylinders, and set it or them vertically on a zinc pan or dish. Then securely stop with a sound cork the lower water orifices of the water jacket, and, having done so, pour into the jacket spacing through the upper water orifice a somewhat concentrated solution of sulphate of copper. This will shortly begin to leak through the cracks or fissures and run into the zinc pan, from which it should be poured, and introduced again and again into the water jacket. The rapid leakage of the solution will after a time be reduced to mere oozing, when it will not be necessary to return the solution so frequently to the water jacket spacing. At the end of the day arrange an air pump so that the pressure can be made to take effect upon the liquid filling the water spacing, which will increase the oozing at first, but as the oozings begin to lose their bluish tone it is a sign that the cracks or fissures are very nearly closed, and if the cylinder is left for a few hours longer the staunching will be effectually performed. The concentrated solution of sulphate of copper is made by sulphate of copper crystals dissolved in water. To obtain a concentrated solution, as many crystals should be dissolved as the water will permit.

WATER COOLING.

The Best Packing.

65 The water pumps of several cars are fitted with fibre washers, as packing joints to their ground covers, and asbestos string in the stuffing boxes. For all packing joints designed to prevent water leaks, nothing has been found so good as asbestos string plentifully smeared with blacklead. It remains watertight far longer than anything else.

Frozen Water Jackets.

66 When the water is left in the engine in an unwarmed motor house, trouble, of course, is expected, and if the frost be at all severe, trouble there will undoubtedly be; but it is rather galling after the water has been drained out of the radiator and engine to find that when the thaw comes, the cylinder jacket is cracked after all. This has happened on several occasions, and more or less puzzled some of the sufferers, as they believed they had taken every precaution to run out all the water, of course opening the drain cocks on the cylinder jackets, and it is here they were deceived. Mud and sediment are apt to collect round the bottom of the water jackets, and as the water drains out of the jackets this sediment is very apt to stop the cock before all the water has been run off. The only safe way is to watch the water running out of the jackets, and directly it stops flowing the tap should be probed with a piece of wire. Nearly always more water will begin to flow, and directly it stops the tap should be probed again and again till no more water issues from it.

Many of the more modern cars have their water circulation so arranged that there is no need for drain taps to the cylinder jackets, as the connections between the cylinders and from them to the main water system are so arranged that the jackets drain into the main system. It will also be noticed in the better designed circulating systems that the drain outlets are so large that there is practically no fear of the orifices being stopped with mud or sediment.

Frozen Water Pumps.

67 It may seem a comparatively easy matter to draw off *all* the water from the cooling system of a car, but in practice this ideal is seldom realised, as in some cases one cannot get rid of enough water to ensure immunity from trouble in frosty weather. When putting away the car for the night in any place where water is likely to freeze, the wise man naturally opens all the drain taps, whilst possibly he will remain until the water has reached the "drip" stage. An

insidious trouble, however, seems to commence the moment he turns his back, for the water pipes, relieved of the warm water, rapidly cool down; there still remains, however, a film of water on the walls of the pipes, which slowly drains away to the lowest point, this in many cases being the pump. While this is proceeding the pump has reached freezing point, when, instead of draining away to the floor, the water congeals in the pump, and the latter is eventually more or less choked by solid ice. The water pipes being in a more protected, and therefore warmer, position, the water will continue to drain down them to the pump, perhaps for a considerable time after ice has formed there, so that the pipes themselves also become choked with a plug of ice where they connect to the pump. In the morning fresh water is put in and the starting handle vigorously turned. Crack goes the pump! The same thing can quite easily happen even when hot water is put in, because the plugs of ice in the pipes take an appreciable time to melt, during which time the blades or gear wheels in the pump still remain fast. It is as well, therefore, to wait for the water to flow freely from the pump tap before turning the starting handle. Unfortunately, there is no way of discerning whether a pump is free when turning the starting handle, because the engine turns stiffly in any case when cold, and one has so great a leverage through the starting handle that the pump spindle may conceivably be badly damaged without one being aware of anything wrong. The spring drive is in such cases of the greatest value, for by watching the behaviour of the spring, which will tend to wind up if the pump be fast, one can prevent any inadvertent damage.—H. G. B.

Breaking of Water Pipes.

68 From time to time we have had complaints as to the breakage of water pipe connections at cylinder tops. On investigation, we have found that this has usually taken place in two or four-cylinder engines when the cylinders have been cast separately. No doubt the reason has been due to the fact that some slight deflection between each cylinder takes place, and as copper pipes are usually sweated into the elbow or T castings they pull away at this point, thus allowing leakage to take place. If any car owner experiences this trouble, the best way to get over it is to saw the copper pipe in two halfway between each cylinder, and then fit thereon a rubber connection, which is clipped at either end to the copper pipe. It will be found that no further trouble will be experienced.

Many engines now have a large top main in the form of a lid casting, which connects up the jackets of all four cylinders, and, of course, with this type of head connection, the trouble we have mentioned does not occur.

Leaky Honeycomb Radiators.

69 Leaks in honeycomb radiators are quickly and effectually stopped by the use of two little flat plates faced inside with leather or rubber. There is a small hole in the centre of each plate, and a small bolt is passed through the two plates and tube, and screwed up with a nut. Care should be taken not to screw up too tightly, or the radiator will be damaged.

To Stop Slight Leaks in Honeycomb Radiators.

70 When a honeycomb radiator, or, for the matter of that, any other radiator, is badly damaged, there is no remedy except to send it to the makers to be properly repaired, but at times honeycomb radiators, especially if they are not quite strongly supported at the sides, will develop very slight leaks. It is quite a mistake to attempt to repair these very slight leaks by soldering, as the result will generally be to cause a leak somewhere else. There is a very simple remedy for stopping them, though it should be clearly understood that it only applies to slight leakages along the edges of the cells of the radiator. For a radiator that is " weeping " a thin mixture of the very finest oatmeal flour should be made. Two tablespoonfuls of flour should be put in a jug, damped slightly, and mixed into a smooth paste absolutely free from any lumps. More water can then be added till the jug is full and the whole mixture can then be poured into the radiator. It will then be found that the flour, which will do no harm to the pump or any part of the circulatory system, will gradually work into the leakages of the radiator and stop them up, so that after two or three days' use the leakage will be entirely cured. The one objection to this remedy is that it is impossible to prescribe it as a certain one.

Bran for Leaky Radiators.

71 The preceding paragraph contains a method of employing flour as a cure for " weeping " radiators. This is supplemented by the following, received from a correspondent : " I have run a car with honeycomb radiator that was not ' weeping ' as you put it, but the action of which was more like a water-pot. My cure was a double handful of bran at weekly intervals for some five months before the car passed

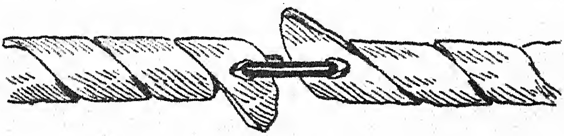
out of my keeping. My relations with the car were not such as warranted my spending any money on it, but I can assure you that this rough and ready treatment kept the car in such a condition that there was no need to add water to the radiator from more than day to day. I must have put in at least a peck of bran, and where it all went to is more than I can say, but it never had the slightest effect on the cooling, nor did the pump which was a rotary vaned pump, suffer.—E. E. LEVERETT."

A Temporary Radiator.

72 During a frost my car stood too long exposed to a north wind, with the result that, on starting for home (twelve miles away), I found the cooler frozen and burst. To get home I borrowed a neighbouring gardener's hose pipe, disconnected the cooler, and after carefully filling the hose fixed it on to the water inlet to the pump and the outlet pipe from the cylinder heads. It took us home and ran thirty miles till I got the radiator repaired.—W. CREBER.

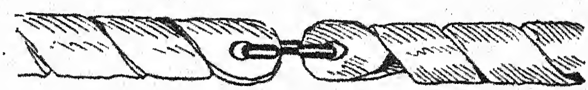
Fan Belts for Grooved Pulleys.

73 So far as our experience goes, the most satisfactory belts for driving a fan through grooved pulleys are twisted leather belts. The wire belts made of a closely wound coil of spring steel are not satisfactory, as they break at the



The ends of the belt before rounding off.

joint very soon, and cannot be rejoined on the road. Some makers supply rope belts, which are even better, but these rope belts must be made to a dead length to fit a particular car, so



The ends of the belt after cutting off the overlapping edges.

that they can hardly be said to be of universal application. In the main, the success of the twisted leather belt depends upon the fastening. It can always be made tight enough by giving it another twist or cutting a piece off it, but if the fastening is at all prominent the belt will be continually coming

off the pulleys unless the grooves are much deeper than in the majority of cases. Some twisted belts are fastened by fasteners of I shape, thus  These are all very well in wide, deep pulleys, but the best form of fastener is the C shape, thus  If this is used and the ends of the belt bevelled off so that there are no sharp edges likely to stick over the pulley flanges, the belt will never come off. Speaking generally, it may be said that whenever a twisted belt comes off it is due to some undue inequality at the joint. Either the fastener itself is too prominent or the corners of the ends of the belt want chamfering off. In making the holes in the ends of the belt to take the fastener, it is much the best to use a proper leather punch, which can be obtained for a few pence at any ironmonger's. This will make a clean round hole, and will not strain the leather in any way, so that there will not be a disposition for the hole to tear. If the hole is bored out with a knife or a gimlet, it is more or less ragged, and the fastener will tear out very much sooner. Another good

The C fastener in position.

plan with a leather belt is to stretch it before use. Take the belt, wet it, and hang a weight on it, leaving it thus for two or three days. This is not indispensable, but it saves trouble, as it means that when the belt is put on it will not have to be taken off to be made any tighter, because the initial stretch will have been taken out of the leather.

It should be understood that these remarks refer to grooved pulleys only. In our opinion, the most satisfactory method of fan driving is by means of flanged flat pulleys and a flat belt with an eccentric adjustment or some form of spring tension.

The Fan in Cold Weather.

74 A good many cars on the road to-day would run better if the fan belt were removed during the cold weather. Of course, this does not apply to cars which are used for town work, but for country driving—provided the pump is in proper order, the fan is superfluous in many instances. Short of the water boiling, an engine runs better and more economically without the fan in winter. A rough guide as to whether the experiment is likely to prove successful can be obtained from summer driving. If in really hot weather

the car can be driven up a first speed hill at least half a mile long without the water boiling, it may be taken as an indication that it is somewhat over-cooled for cold weather, and that therefore in all probability the fan can remain idle with advantage on cold days. At any rate, the experiment is a very simple one, as it is only necessary to remove the belt, and then if the water is found to boil to put it on again. Another rough indication as to the probability of the removal of the fan belt being an advantage is in the time the engine takes to warm up. Many cars will not pull well till they have been running for nearly an hour, but they ought to get warmed more quickly than this, as a quarter of an hour's driving should be quite sufficient to bring the engine to a proper working temperature

Clearing the Circulating System.

75 The water-circulating system may be cleared of impurities after running with dirty water by filling up the tank with a strong solution of soda. Run the engine for a few minutes, and draw off the soda water; then wash out with clean water. For this purpose as much common house soda as the water will dissolve should be used.

Fouling Radiators.

76 Whenever possible, rainwater only should be put into radiators, particularly honeycomb radiators, in which the water spaces are hardly thicker than a good stout sheet of note paper. Short of rain water, river water is best, but water from wells should be shunned, as it generally carries a large percentage of lime in suspension, which is precipitated by the heat and thrown down upon the inner surfaces of the cylinder jackets, and the radiator tubes in a hard layer, which thickens every day, particularly if the radiator loses much or leaks, and so requires frequent replenishment. When the furred coat amounts to any thickness, the engine will run much hotter than before, as the deposited layer is a very bad conductor of heat, and so the evil continues to grow. It will repay any car owner who owns a motor house or shed to gutter it, and lead the rainfall into a butt or tank for use. If plenty of rain water can be caught and stored, it is much better than hard water for body washing.

A Useful Water Strainer.

77 A useful and easily-made water strainer may be made in the following manner: Take a metal ring or a piece of wire bent into a circle, and stitch on to it a long,

conically-shaped bag made out of old linen. The ring should be sufficiently large to rest upon the edge of the water filling pipe, the bag dropping well down into this.' If circumstances permit, it may be left in position, simply screwing the cap covering the filling pipe into position on top of it. Thus one has the strainer in position, and it will obviate all possibility of any foreign matter being taken into the water tank or the circulating system. It is a simple thing, but it guards against all possibilities of getting the pump choked, the water circulation stopped, and the engine overheated, and consequent damage and delay.

All the better cars are provided with gauze strainers under the filler cap, but these occasionally get damaged or lost, and then for a temporary makeshift the linen strainer comes in useful.

Steaming at the Radiator.

78 One should observe how hot the cooler gets in the ordinary way, and also whether any steam is given off, because then, if any noticeable increase of heat or steam occurs, one will immediately conclude that the water circulation is failing, and attention will be given to the point at once. The chances are that the pump is the cause of the trouble. It will either have become deranged in itself, or, what is more likely, it will not run through the driving connection having temporarily failed. In thermo-syphon systems the most usual cause of steaming is the loss or slipping of the fan belt.

Removing Fur Deposit.

79 It is well known that rainwater is the correct medium to use in the radiator for the dissipation of heat necessary to keep the engine at a proper working temperature; rainwater being free from solid matter, there is no tendency to the formation of "fur" in the system.

"Fur" deposits readily when "hard" water is used, and the solids deposited in the radiator and piping are sometimes rather difficult to remove satisfactorily, and it is needless to say more than that, if there be any interference with the circulation of the cooling water, overheating is apt to result. As one or two cases of furred radiators have come under notice it may not be out of place to describe a remedy for the trouble.

In the early stages, *i.e.*, when there is little deposition, a strong solution of washing soda is sufficient to effect a cure. Dissolve 1 lb. of soda in two gallons of hot water, fill up the radiator, start the engine, and let the solution circulate for ten

minutes or so. Drain off, fill up the radiator with pure clean water, or open the tap at the bottom of the radiator, and, letting water from the hose run in at the top, keep the engine running to get rid of the last traces of the alkali.

When furring has reached an advanced stage, however, the above treatment is worse than useless, and stronger measures have to be adopted, and one of three treatments are open to the motorist. (1) One of the advertised preparations (Moplen, for example), (2) dilute acid, or (3) strong alkali. Before using methods 2 or 3 it is advisable to don old clothes and old gloves, for hot acid and alkali are very corrosive.

With the acid treatment it is not necessary to remove the radiator, which is one point in its favour. Prepare a solution of hydrochloric acid in the proportion of one part acid to fifteen-twenty parts of water. Fill up the radiator with this solution and start the engine, so, keeping the solution circulating for about five minutes, then drain off.

Have ready the washing soda solution mentioned above, let this circulate for a minute or so in order to neutralise the acid remaining in the water system, then drain off and flush thoroughly with water. This process may be repeated if necessary, and usually results successfully.

For the strong alkali method it is necessary to procure ½ to ¾ lb. of caustic soda (but taking care in handling this, as it is most inimical to the skin) and dissolve it in two to three gallons of water. Unship the radiator and set it outside the motor house to drain. Then fill it up with petrol, blocking up the outlet so that no petrol may escape, put on the radiator cap, and set it aside for six to twelve hours. The petrol serves a double purpose, it dissolves any grease which may be in the tubes, and also loosens the fur deposit to a limited degree.

After standing for the time mentioned, drain off the petrol, strain and set it aside for future use. Then, after putting the radiator in place on the car again, fill it up with the caustic soda solution and allow this to circulate for half an hour or so. Then wash the system thoroughly with fresh water.

Either of the latter methods will remove the most obstinate furring, but the following are points to be noted. The acid or soda method should only be used under the direct supervision of the motorist or carelessness may result in some damage. Wooden buckets should be used for making solutions. The operator should dress for the part—that is, use old clothes and gloves, and should avoid splashing of the solutions on engine or coachwork. Rubber and caustic soda do not agree, so new rubber connections should be ready.—PAGE.

IGNITION.

Broken Contact Breaker Spring.—Loose Magneto.—Some Magneto Timing Tips.—An Ignition Synchronising Device.—Another Method.—Stiff Bell Crank Lever causes Misfiring.—Insulation of Magnetos.—Always Maintain the High-tension Circuit.—Setting of Low-tension Contact Points on Magnetos.—To Ascertain when the Contact Points Separate.—Replacing Magneto Coupling Correctly.—On Magnetos.—Protect the Magneto.—Magneto Timing on Talbot Cars.—A Mysterious Magneto Trouble.—Some Magneto Tips.—The Advantage of Double Ignition.—A Simple Form of Dual Ignition.—A Curious Case of Overheating.—Magneto Fatigue.—Tightening Battery and Coil Terminal Wires.—Flex Terminals.—An Easily-made Terminal.—Making Electric Connections—Varnish for Electric Terminals.—Sparking Plug Points.—A Sparking Plug Joint.—A Simple Sparking Plug Cut-out.—Sparking Plug Test Brackets.—Periodical Examination of Sparking Plugs.—Sparking Plug Holders.—Multi-point Ignition with Single-pole Plugs.—Two Simultaneous Sparks in a Cylinder.—Spare Ignition Sparking Plugs.—To Prevent the Fouling of Sparking Plugs.—A Strange Cause of Misfiring.—A Remedy for a Coil Ailment.—Misfiring on Sleeve Valve Engines.

Broken Contact Breaker Spring.

80 I was stranded one day by the small flat steel spring which operates the contact breaker on a Bosch magneto breaking. It was a brand new car with magneto ignition only. After some cogitating, I got a piece of an old cycle inner tube, folded it, and squeezed it in between the rocking arm of the contact breaker and a convenient boss or screw that luckily lent itself to the purpose. We had very few tools on board, but I had been snaring pike in a trout stream, and had a piece of fine brass wire in my pocket. Making a contact with a piece of this wire doubled and with the rubber acting as a spring, the magneto worked as well as ever, and has been running ever since with it, as the owner does not want the trouble of changing it.—F. W. Beckford.

Loose Magneto.

81 A curious accident occurred the other day which shows that even expert motorists may be hard put to it to explain the reason of knocking or other fault in a car. A four-cylinder engine of well-known Belgian manufacture ever since the day it was erected had given trouble through knocking. Everything that could be done to it was done, and over and over again fresh experts tried their hand; but all to no avail. At last, as a forlorn hope, I determined to make one last attempt to solve the mystery, mentally resolving to overhaul every item of the motor if it took me a month or more. The usual routine was gone through, the bolts holding the engine to the inner frame were examined, as were also the flywheel for looseness, the piston heads for carbon deposit, the ignition, etc., none, however, being the cause. At last, when watching the engine running in the garage it struck me that the high-tension magneto was vibrating a good deal more than is usual. Thinking the clip that held it to its bed was getting loose, I tried to tighten it, but the butterfly nut was as far home as it could go. Clearly, then, packing was wanted between the magneto and the clips, and so I began to unscrew the nut. Judge of my surprise when after giving it a couple of turns the knocking vanished completely, but occurred again as soon as I tightened the nut once more. As it turned out, the alignment of the magneto was incorrect, and half an hour spent in readjusting matters by fitting packing pieces under the magneto cured the trouble completely, and as I did not tell the owner how simple the reason was, he treats me now with unwonted deference.—A. J.

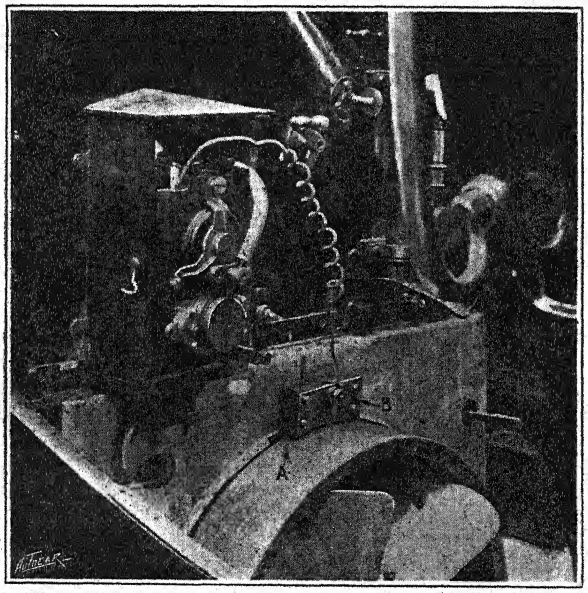
Some Magneto Timing Tips.

82 One of the most vital portions of a car, and one which is, unfortunately, the least understood, is the magneto. When the car is delivered, the magneto firing point is supposed to be properly set, but occasionally it may require alteration if it be too far advanced or too much retarded. In which direction the fault lies may easily be detected; if it be too far advanced, the engine will knock when suddenly called upon to do hard work; if it be too much retarded, the engine will not develop enough power, and may not respond to the throttle lever. Theoretically, and in nine cases out of ten actually, the proper way to time a magneto is to select the most accessible cylinder, set the piston on the dead centre at the top of the compression stroke, retard the spark, and set the platinum points

of the magneto contact breaker so that they are just about to separate. Should this be incorrect, and an alteration be imperative, the friction cone or clamp fastening on to the armature-shaft and carrying one of the dog couplings should be loosened, and its position altered in relation to the armature. It may seem paradoxical at first, but to retard the firing point, the coupling should be moved slightly (say, not more than 2 mm. at a time) *in the direction of rotation*, and to advance it contrary to the direction of rotation. The reason for this is that when advanced the firing point is some way down the compression stroke, so that sufficient *lead* is given, by which is meant sufficient time for the explosion to reach its highest point of efficiency, as the piston reaches the dead centre. A good way of remembering this is to think of the alarum indicator on an alarm clock. To call oneself early the indicator is put back in a direction contrary to that in which the hands travel. The methods of driving magnetos are many, but we will deal with three of these only. First, the chain drive (not to be confused with chain-driven distribution gear)—an awkward, much to be condemned system only found on out-of-date cars; secondly, by means of dog clutches and an Oldham joint; and, lastly, simply by two dog clutches. The last named method is the most satisfactory and the most simple. Dealing with the first method, it is highly important to mark both chain links and sprocket teeth with a file, so that if the magneto be taken down and cleaned, the chain may be easily and correctly replaced. With the second method, the driving-shafts should be turned by means of the starting handle into a convenient position, and the three separate members should be marked separately with a punch, so that the three punch marks are all in a line. With the third method the dogs are usually held on by cotters, so that it is only necessary to note that both of the ends of the cotters are uppermost, and a mistake cannot occur. Great care should be taken to see that the distributer brush at the moment the break is about to take place is on the segment leading to the cylinder, the position of the piston of which has been determined. This is done by removing the distributer cover, and following out the connections. If the position of the coupling have to be altered in relation to the armature, the special spanner provided with the magneto should be slipped over the central nut on the contact breaker and held firmly, when another person slightly shifts the coupling. These spanners are not always supplied, but every car owner should insist on being provided with one when the car is delivered.

An Ignition Synchronising Device.

83 The following is a very simple device which will be found most useful in indicating exactly under working conditions when ignition is taking place on engines fitted with high-tension ignition, either magneto or battery. By its means the exact position of the flywheel when the spark takes place can be determined while the engine is running, and from this can easily be deduced the position of the pistons. Measuring



The ignition timing indicator, A being one of the studs let into the flywheel and B the graduated plate.

circumferentially on the rim of the flywheel, the number of inches before dead centre at which the spark takes place will form a very useful basis of computation. The mechanism is arranged as follows :

If it be intended that the spark shall take place within an inch or so of the dead centre, four knobs A, which may conveniently consist of ¼in. round head brass screws, are screwed into the rim of the flywheel at the points corresponding to the respective top dead centres of cylinders 1 and 4

and 2 and 3 in a four-cylinder engine, and fixed in any convenient manner on the dash vertically above the flywheel is an insulated brass plate B, the lower edge of which is trimmed to a concave surface about $\frac{5}{16}$in. clear at all points of the rim of the flywheel, this plate being in the plane of the knobs A, so that when these knobs pass under it there is only about $\frac{1}{16}$in. between the top of the knob and the concave edge of the plate. The edge of this plate is divided into inches and marked with radial lines, the division, which is exactly opposite the knob A when the pistons are at dead centre, being marked zero. A connecting wire is now led (see accompanying illustration) from one of the terminals of the magneto to the plate, and the engine started up, the lead from that particular cylinder being disconnected. The spark, instead of taking place in that cylinder, will now take place between knob A and plate B, and its exact position on the plate can easily be noted by the eye, and from the afore-mentioned scale marked on B the exact position may be measured in inches on the rim of the flywheel at which the spark is taking place before or after the dead centre. This device is the invention of Mr. T. Blackwood Murray, the managing director of the Albion Motor Co., Ltd.

Another Method.

84 It has occurred to me that the device described in the preceding hint might be somewhat simplified by doing away with the brass knobs and the necessity of tapping them into the flywheel. I would suggest that on the circumference of the flywheel a piece of paper be fixed somewhere in the neighbourhood of where the spark ought to take place, the paper being of sufficient size to allow a margin on either side of the estimated point. One of the high-tension wires could then be fixed so as to form a small spark gap between its end and the flywheel. The spark would puncture the paper and leave a small black mark which would show exactly where the spark took place.—J. Dalrymple Bell.

Stiff Bell Crank Lever causes Misfiring.

85 I have just fitted a new magneto to my car to replace one which has not given satisfaction. The new magneto ran well for about 2,000 miles, but it then began to misfire badly when the engine warmed up after twenty miles running, for instance. Upon inspecting the contact breaker, I found that the bell crank lever was very stiff in its bearing, which in this case is formed by a fibre bush. The recoil spring actuating this bell crank lever to bring the platinum tip into contact with the screw subsequently to each break is very

slight, so that it is essential for the working of the magneto that the lever shall be quite free in its bearing. I traced the cause of the misfiring whilst away from home, and for a time was at a loss for a tool to enlarge the bore of the fibre bush. A rat-tail file or a reamer was the tool required, but eventually I found that the long screw in the centre of the contact breaker which holds it to the armature spindle just fitted this bush, and by using a threaded portion as a file a few minutes' operation enlarged the hole sufficiently for my purpose. Since I have eased this bearing I have had absolutely no trouble with the magneto. I have experienced this difficulty before, but in previous cases I have not been forced to use a makeshift tool for the purpose of enlarging the hole. It is highly probable that damp had got into the contact breaker and caused the bush to swell, or else perhaps the oil would have the same effect upon it when it became hot.—E.J.B.

Insulation of Magnetos.

86 In any type of magneto care should be taken, in washing the car, that no water is allowed to get on to it, as so surely as it does trouble will be experienced with short-circuiting. This short-circuiting is most annoying, because it is difficult to locate the fault. The slightest film of moisture is sufficient to cause the "shorting."

Always Maintain the High-tension Circuit.

87 Do not make use of the safety spark gap except for an emergency. For instance, do not allow one secondary wire to remain detached from the plug when one cylinder is out of work. This puts a strain on the winding insulation, and may ultimately lead to a breakdown.

Setting of Low-tension Contact Points on Magnetos.

88 Much unnecessary trouble is experienced by users of high-tension magnetos by failing to set the points of contact correctly. The usual error into which the uninitiated fall is that of adjusting the platinum-pointed screw too far away from the platinum point contact on the lever. It will be found that if the adjustment is made so close that contact is only just broken as the cam presses on the lever in its travel, the best results are obtained. About one-hundredth of an inch (the thickness of the average visiting-card) is an excellent distance for all-round work. If the points are set much further apart than this, a very destructive spark takes places between the points at the moment of breaking the primary circuit. This rapidly burns away the platinum contacts, and necessi-

tates frequent adjustment. In most tool kits the magneto maker's gauge is found. This gauge enables the width of the gap to be set to the best advantage.

To Ascertain when the Contact Points Separate.

89 The method hereunder described is a simple way of ascertaining accurately when the "break" takes place. With the magneto in its usual position, it is very difficult, and sometimes nearly a matter of impossibility, to observe when the break at the platinum points really takes place. To obviate this difficulty, place a cigarette paper between the platinum points and pull it gently. The instant the points separate, the paper will be released. Care should be taken that no fragment of the paper is left between the points.

Replacing Magneto Coupling Correctly.

90 Most magnetos are driven off one of the distribution wheel shafts by some form of flexible coupling. This coupling often consists of two tongues cut on a disc, the tongues being at right angles. One of these tongues meshes with a groove in a boss on the distribution wheelshaft, while the other meshes with a groove on the magneto-shaft. Before taking down magnetos, it is always as well to mark the jaws and the tongues carefully, so that they may be inserted in the same place when putting back in position.

On Magnetos.

91 The best way to keep magneto machines in order is to refrain from doing anything more than is absolutely necessary to them, such, for instance, as keeping the contacts clean and free from grease, and keeping the bearings sufficiently lubricated without flooding them. We are led to write this by reason of the fact that a car owner remarked to us that his magneto was no good, as it soon lost its power and was difficult to take down. Having ascertained the make of the magneto in question, we felt certain that some curious circumstance was attached to it, and made further enquiries, the result of which was that we found the magneto had been dismembered, and the permanent magnets left for some time without keepers, *i.e.*, a piece of iron or steel bar across the ends of the U magnets. This resulted in the loss of a certain amount of magnetism, and a consequent diminution in the power of the machine as a producer of electric current. It is only under extraordinary conditions that the removal of the magnets is necessary, and therefore practically they should never be touched.

Protect the Magneto.

92 If given a fair chance a good magneto is a most reliable instrument, but we must say that many magnetos do not have a fair chance. They are put in such a position that they are constantly bombarded with splashes of oil from the engine, flywheel, or gear, and very often, too, they are exposed to wet not only when the car is over-copiously washed, but when driving in heavy rain they are sometimes just in a position where they get quite a lot of it. Now, a little wet or a little oil does not hurt the magneto, but when the machine is constantly soddened with one or the other, trouble is apt to arise; in fact, it is sure to arise eventually, and it could all be overcome if the magneto were covered. Many cars have a neat, strong leather cover which completely envelops the magneto machine, and we certainly think this is a desirable precaution in the majority of cases. It is true that some magnetos are so placed that they are protected entirely, or almost entirely, from wet or oil splashes, but even these would be better for being covered up, as the cover keeps dust out of the machine, and that must tend in the long run to a longer life of the distributer and working parts generally. Magneto manufacturers are already making weather-proof magnetos, and car designers even going so far as completely to enclose the magneto within the engine casing.

Magneto Timing on Talbot Cars.

93 Considerable trouble and annoyance have been caused to owners of magneto ignited engines by the fact of their magneto drive slipping, or otherwise getting out of

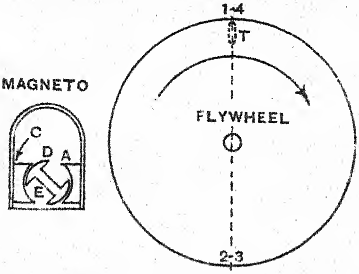


Diagram for setting magneto armature.

adjustment with the other timing of the engine. With reference to the small type of Bosch magneto used on the 15 h.p., 20 h.p., and 10-12 h.p. Talbot cars, Mr. Garrard issued a

diagram and brief instructions which enabled any person of ordinary intelligence to reset his magneto for himself, provided a suitable driving device be fitted. In the Talbot cars the driving device can be slacked off and the armature moved round with the fingers to the position desired, when the device can be clamped up securely with the binding screw. On the previous page we have the magneto and flywheel in diagram. On the flywheel is a timing mark, 1—4, while to the crank chamber is attached an index finger T. When it so happens that the magneto is improperly timed or has in some way or other got out of adjustment, it can be set in a satisfactory way as follows: Open the compression taps on the cylinders and rotate the engine until the timing mark on the flywheel 1—4 is level with the timing index T attached to the crank chamber. Then remove the cover from the top of the magneto and expose the armature E so that its movement can be easily observed. Then set the armature E to the position shown in the sketch—that is, with the back end D on the vertical centre line of the magneto. With the armature in this position, clamp up the driving device with the binding screw provided, start up the engine, and observe the effect. If knocking is experienced, then the armature must be again adjusted, the point D being set back slightly towards A. In some cases, in order to obtain the best result, it may be found necessary to set the point D of the armature back until it is halfway between C and A when the flywheel is in the position indicated in the sketch.

A Mysterious Magneto Trouble.

94 A derangement which gave several hours' worry was traced to the sluggish action of the rocking lever, which serves as contact breaker (Simms high-tension magneto). We had driven over two hundred miles at a stretch in heavy rain, and the steel pin axle, which works in a fibre bush, rusted slightly overnight. This gave rise to the sluggish action at low speeds, and therefore to the irregular firing. At high speeds the cam knocked the lever out of contact with such violence that the rebound brought it back into contact with considerable regularity. The same stiffness of the rocking lever may occur if the car has been left standing for some time in a damp place.

Some Magneto Tips.

95 When a dog clutch is interposed between the magneto and its driving shaft, one is liable to reconnect it the wrong way if not careful, so that the magneto is set

180° in advance of its original timing. When this happens every effort to start up the engine results only in spitting and banging in the exhaust box, the spark occurring somewhere on the exhaust stroke. This mistake can easily be corrected by replacing the magneto-shaft in the alternative position. By the way, it is a good plan to notice the order of the high-tension leads before disconnecting them from the magneto, otherwise an inexperienced motorist will soon be involved in an awkward dilemma. Another point where beginners often go wrong is in regard to the lubrication of the magneto, as they sometimes swamp the machine with oil to the destruction of the wiring and other vital parts. On the other hand, the magneto is so beautifully made nowadays that one is apt to forget all about it till something happens to the mechanism. Considering the high rate of speed, and that it often runs for hours day after day, proper lubrication is essential, and it should be given a drop of oil regularly before going out for a long run.

Another trouble to which magnetos are liable is due to one of the two fibre rollers which actuate the make and break wearing more than the other. When this happens the magneto begins to fire erratically, sometimes, in the four-cylinder type, only two cylinders firing, especially at low speeds, while every now and then the other pair will chip in and make the engine spurt forward again. Cases have been known where the outer cap, which can be moved through an angle to vary the time of firing, has been trimmed off to make it easier to move. If this is done carelessly, a certain amount of play takes place which has the effect of making one pair of cylinders cut-out altogether. One other point remains for notice. When a clamp is used to hold a magneto to its seat, one bolt only is used as a rule to draw its two halves together—a somewhat insecure fastening which cannot, of course, be absolutely relied upon. It is very important to see that the nut does not work loose, for if not fastened down securely the magneto is liable to be seriously damaged. Complicated though it appears, the magneto is really a simple article.

The Advantage of Double Ignition.

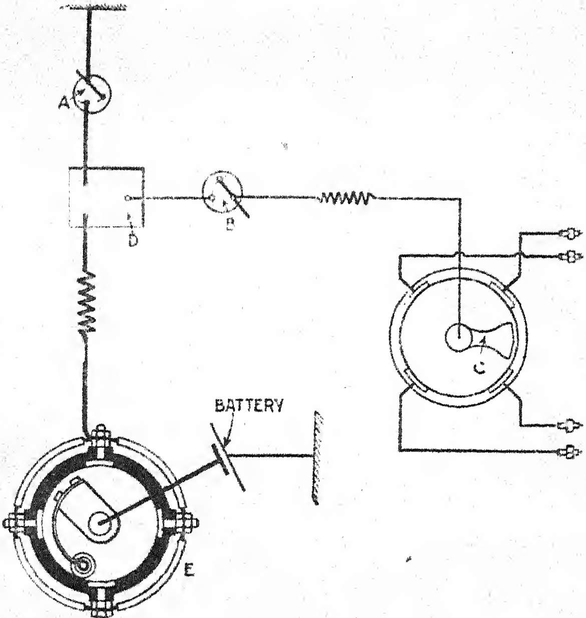
96 A good many motor cars are still fitted with two ignitions—mostly high-tension coil and accumulator and high-tension magneto—and, as Dr. Watson proved in his paper, "The Relation between Power and Spark," published in *The Autocar*, the power obtained with two sparks is considerably greater than when only one spark is employed. Pro-

vided that both sparks in each cylinder occur at the same time, it appears a good plan always to run with both sets of ignition on. In addition to the increased power, this ensures that each set is in working order. The only trouble is to ascertain that the sparks are synchronous. This can easily be done by turning the engine with the plugs from one of the cylinders taken out, but connected up and earthed on the cylinder cover or some part which is in metallic contact with it. Then advance the commutator lever until the spark in the coil plug occurs at the same time as in the one fired by the magneto, mark the position on the ignition quadrant, and then, after starting up with the coil ignition retarded, the magneto can be switched on, and then the coil firing advanced to the position previously marked, when the two ignitions must take place at the same time. I have done this on a four-cylinder car, and must say that the results have been satisfactory, and that the car's power has increased, although, of course, the ignition must be regarded as fixed.—CHARLES T. W. HIRSCH.

A Simple Form of Dual Ignition.

97 Many engines which are fitted with high-tension magneto ignition are also provided with facilities for fitting a contact breaker. In some cases the contact breaker is actually fitted but not used. It is our object to show a simple dual system by which a single-cylinder coil can be used in conjunction with this contact breaker and the existing set of sparking plugs. This dispenses with the necessity for carrying four separate coils and another set of plugs, or the fitting of a separate high-tension distributer. In the majority of cases the accumulator ignition is only used for starting or for slow running, and in such a case our suggestion would amply suffice, whilst it could, of course, be used for continuous running. The accompanying drawing shows diagrammatically the idea, which consists of coupling together the four terminals of the contact breaker E (in the case of a four-cylinder engine), one of these terminals being coupled to one primary terminal on the coil. The other primary terminal is connected *via* a low-tension switch to "earth." The secondary terminal of the coil is connected *via* a two-way high-tension switch B to the arm C of the distributer on the magneto, in such a way that the distributer arm can be switched either into the coil circuit or the magneto circuit. The actual point on the magneto to which the wire is connected varies with different types of magnetos, but a little examination will enable one to ascertain how the wire should be connected up.

Assuming the system to be arranged as described, it will be seen that, as the engine rotates, the primary contact breaker E completes the circuit at or about the top dead centre, the period being adjustable by adjusting the contact breaker in the ordinary manner. On the circuit being so completed the secondary current is induced in the coil and supplied, if the high-tension switch B is "on," to the distributer arm.



A simple form of dual ignition.

A, low tension switch.
B, high tension switch.
C, magneto high tension distributer arm.
D, coil.
E, low tension contact breaker.

This arm, therefore, now supplies the current to the four sparking plugs in rotation. It will be seen that the only parts common to the two systems are the distributer, the high-tension wires, and the sparking plugs. As the distributer is a purely mechanical element, it follows that the system would operate in spite of electrical breakdown of the magneto. Thus the battery system could be used as a stand-by, provided that the sparking plugs are in order.

A Curious Case of Overheating.

98 It is a commonplace of the repair shop that ignition troubles often lead to overheating, but we imagine that few repairers would rapidly diagnose a steaming radiator as caused purely and solely by dirty platina, breaking too widely on the contact breaker of a magneto. Such a case, however, came under our notice, and baffled detection by rather a clever motoring medicine man for several days. A fresh contact breaker from the neat Bosch case of spare parts was finally fitted, though the expedient was rather in the nature of an arrow shot at a venture. Finding that the cooling system immediately began to function perfectly, the discarded contact breaker was carefully scrutinised, and found to exhibit no other defect than a very wide break of the platina, and the fact that they were dirty and did not register squarely. The effects of these flaws were obviously late firing and imperfect combustion, leading to an over liberal supply of mixture in the effort to obtain a normal speed of the engine.

Magneto Fatigue.

99 From time to time we have heard instances of what, for want of a better term, may be called magneto fatigue. They have always occurred on a long continuous drive, so that the symptoms have seemingly been those associated with fatigue. Our own experience on one occasion is probably typical of that of others. We were making a through run of 175 miles with only a short stop for lunch, which we had with us on the car, and disposed of it very quickly. All went well for 150 miles, when the engine began to miss badly on the magneto. As we were pressed for time, we did not stop to investigate, but switched over on to the accumulators. After the ignition had been duly advanced, the engine fired quite regularly on the accumulators, and we finished the journey without another misfire. When we took the car out again a day or two afterwards, it ran quite well on the magneto, although nothing whatever had been done to it, nor had the plugs been changed in the interval. To all intents and purposes the magneto had apparently become fatigued. There have been several explanations of this, but none of them appealed to us as being at all convincing, with the exception of one, suggested by a correspondent, Mr. S. B. Macauley, who says that he has found in several instances with a Daimler car that this so-called fatigue is nothing whatever of the kind. It is simply the platinum points of the magneto contact-breaker that need attention; they need taking out and touching up

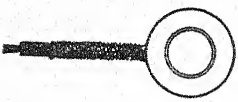
with the finest emery-cloth. Our correspondent attributes the recovery of the magneto from its symptoms of fatigue to the simple fact that when it is switched off the platinum points are simply hammering together, and as they are temporarily relieved of the current, owing to the magneto being switched off, and the accumulators put into operation, the platinum points are automatically hammered flat again. In fact, Mr. Macauley tells us he has known people to face up their platinum points in this manner, and thus save themselves the trouble of taking out the contacts and polishing them in the usual way. In some magnetos, however, this method would not apply, because when the magneto is cut out of action by shorting the primary circuit the contact-maker still remains in the primary circuit, and passes current just the same as when working in the normal manner.

Tightening Battery and Coil Terminal Wires.

100 There is a right and a wrong way to do this. The right way is to twist the bare part of the wire or cable round the terminal in a clockwise direction, and then tighten up the terminal nut. The reason for this is that, as the nuts have right-handed threads, the fact of tightening up the nut tends to pull the wire round more tightly. If the wire be twisted round in an anti-clockwise direction, tightening up the nut tends to uncoil the wire, and it will slip from under the nut whilst it is being tightened or when the vibration of road work comes into play.

Flex Terminals.

101 In all cases where flexible electric wire is employed on a motor car, difficulty is experienced in making a firm and lasting connection. The average flex is too thin and flimsy to stand the usual copper terminal, but in some cases the

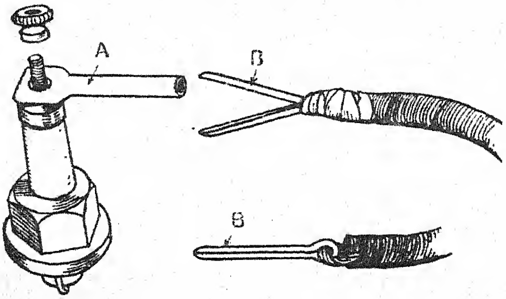


Simplex terminal can be used with advantage. These terminals, as most of our readers are aware, are somewhat like sail eyelets. To attach them the wires are bared and divided, the terminal slipped between the wires and twisted round, and the terminal hammered up with a light hammer. When using flexible wire, as in a case where electric lamps or an electric horn are employed, the same procedure should be followed, but before hammering up the terminal a short piece of fine wire—a hairpin of medium thickness would do—should be bent in half, and made to encircle the terminal. One end should

be laid along the insulation of the flex and the other twisted round it, as shown in the illustration. When the terminal has been hammered up a permanent job will be the result, and there will be no chance of the terminal breaking off. Owing to its light construction, the insulation of flexible cord is very susceptible to acid. To overcome this, each lead where it enters the accumulator box should be encased in the vulcanite tubing used for encasing Bowden cables.

An Easily-made Terminal.

102 The accompanying illustration shows a satisfactory terminal which can be used either for high or low-tension wires, accumulator connections, and wires from electric lamps. A is a piece of copper tube flattened at one end and perforated

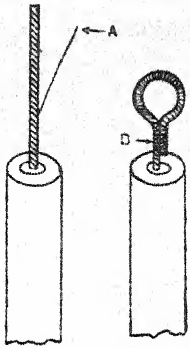


to fit the sparking plug, commutator, or accumulator terminal. B is a split pin, which fits the tube A closely before being split. This split pin is attached by its loop to the wire (high or low tension), and well secured by adhesive tape. The chief advantages are: Ease of detachment, excellent contact, and security from shaking loose.—G.F.A.

Making Electric Connections.

103 A sketch of an excellent method of making electric connections with the wire itself is given herewith. The insulation must be cut round at a convenient distance from the end, 1¼in. to 1½in. usually being the extreme amount required to make a connection. The stranded wires should be twisted tightly together; one or two of the wires, according to the thickness of the strands of which the cable is composed, are taken apart, as shown by A, the cable then being retwisted. The wire should then be formed into a loop round a piece of metal or the terminal itself to a nice easy fit. The end

of the wire after forming the loop should lie parallel to the wire at the beginning of the loop. The stranded wires which have been taken apart are then used to bind the end of the loop to the main body of the cable, the whole being soldered together with soft solder, which will flow easily without having to use a great deal of heat. Particular care should be taken to use resin instead of hydrochloric acid reduced by dissolving zinc in it, or one of the many acid soldering fluids sold. The objection to using such fluids is that they set up corrosion and a chemical action at the joint, offering a high resistance to the current, and there is no doubt that the same cause is responsible for the ignition delays which some motorists experience with their cars.



Varnish for Electric Terminals.

104 Electric terminals which happen to be in such a position as to be subjected to water or mud accumulating upon them can be effectually prevented from possible short circuits by painting them with a varnish composed of ordinary red sealing-wax dissolved in a little petrol. This varnish is made by putting into a small bottle a quantity of small pieces of sealing-wax, covering the latter with spirit and occasionally shaking it. If the varnish should prove too thin, add a little more wax or leave the cork out of the bottle until some of the spirit has evaporated. If it is too thick, add sufficient spirit to bring it down to the required consistency. In order to prevent the varnish retaining the brittleness of the sealing-wax, a little linseed oil should be added. For those who do not care to go to this trouble, a little melted paraffin-wax can be used for the same purpose. Every household contains in the ordinary way candle paraffin-wax of sufficient quality to do this. Either of these methods is as satisfactory as binding with insulating tape.

Sparking Plug Points.

105 The junior generation of motorists are in one respect actually at an advantage as compared with the more experienced, for long familiarity with trembler coils has made the latter careless about the gap at the sparking plug points, which is a more important matter where high-tension magneto is the ignition concerned.

For instance, a certain motorist with a long and varied experience of cars and their peculiarities recently confessed himself beaten by the eccentric running of his four-cylinder engine. It was very difficult to start, and when under way ran without any balance, as if two cylinders were developing about double the h.p. of the rest. He had verified the compression, tested the inlet joints for air leaks, overhauled the interior of the magneto, etc., when one day a novice sauntered in, and, after a casual inspection of the visible details, set the points of a sparking plug with a penknife. Three of the four plugs had electrodes considerably shortened by the hot magneto spark, and consequently giving a wide gap, and this trifling and elementary derangement was solely responsible for the trouble.

A Sparking Plug Joint.

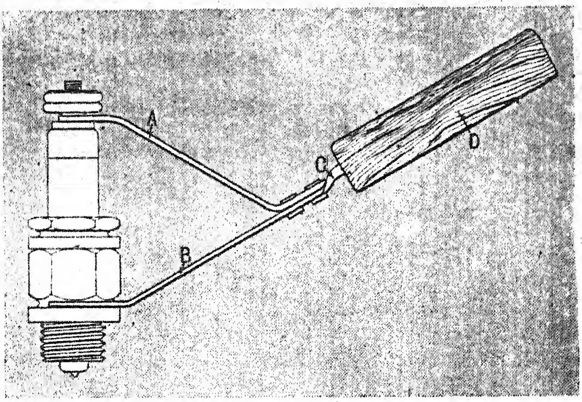
106 Occasionally on the road it is found that a loss of compression is taking place past the copper washer beneath the spark plug flange, and that a spare washer is not available. An excellent substitute can be made by cutting a piece of $\frac{1}{16}$in. copper wire the right length and bending it round circularly so that the ends overlap. Then give each of the overlapping ends a tap with a hammer to reduce the thickness to about one-half, and so that they fit together fairly. On screwing up tightly it will be found that this will make a sufficiently good temporary joint.

A Simple Sparking Plug Cut-out.

107 The method usually employed for testing an engine —by cutting out the ignition of all the cylinders but one—is a very simple and useful one. Where a trembler coil is fitted, the usual method is to hold down the tremblers of all the coils except one, allowing only one of the cylinders to work. Where a non-trembler coil is fitted, it is more difficult to cut out one cylinder. For this purpose a wire has to be disconnected either from the contact breaker or the coil. The device which we illustrate is intended to overcome this difficulty, and may be used with any kind of sparking plug, whether operated through a non-trembler or trembler coil or magneto.

The device merely consists of a fork of some thin strip conducting material, the ends of the arms A and B of the fork being split, whilst the handle portion C is driven into an insulated grip D. To cut out the ignition of one cylinder this device is held up to the sparking plug of that cylinder, so that one arm touches the terminal of the sparking plug and the other either the body of the plug or any part of the

engine. The current will now short-circuit from the terminal through the arms A and B to earth without causing a spark at the plug points. One or the other of the arms can be fitted underneath the binding screws of the sparking plug, and the device bent upwards or downwards, so as to bring the other

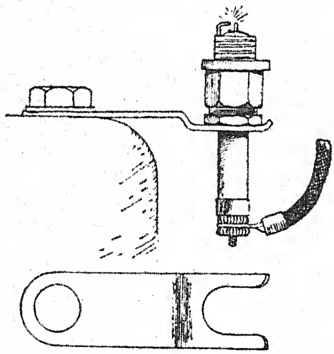


arm into or out of contact with the body of the plug, and so provide a fixed cut-out, which can be used during testing somewhat after the manner of the cut-out plugs used on some magneto ignition systems. This is a little instrument which can be made by anybody and carried in a toolbox to be used when required.

Sparking Plug Test Brackets.

108 To all motorists, and more especially to the make-shift amateur, there sooner or later comes a day when ignition tests are being carried out with one or more of the sparking plugs exposed, in order that the spark may be verified by actual sight. This is usually done by unscrewing the plug after taking off its wire, recoupling up the wire, and then balancing the plug on some convenient corner of the engine head. Several of the minor annoyances which render the most peaceful life chequered at times are known to occur in this process. One is that the terminal end of the plug has an aggravating habit of tumbling into earth contact and short-circuiting the spark; another is that the plug will roll off the engine, and as the earth return is thereby very possibly destroyed (if the plug hang swinging), a considerable strain

is thrown on the coil, and eventual failure of the internal insulation has often been produced in this way. Motorists who are particular about details may value a suggestion which always simplifies this process. A small metal bracket may be rigged up as per enclosed sketch. One end of it is



eyeleted, and may be threaded over any convenient bolt near the plug orifice. Plug tests are then made without detaching the wire at all; the nut on the central electrode is simply slacked back a little, the plug removed, and hung inverted in the forked end of the bracket while the tests are made. The bracket further comes in handy when cleaning a plug that is too hot to hold.

Periodical Examination of Sparking Plugs.

109 Because your engine starts up well first time round every day, runs well to the ear, and seems to pull all right, do not leave your sparking plugs unexamined from one month's end to the other. You will ensure the extra polish of speed and veneer of power if you take these fittings out from time to time, say once a month, and scrape all the hard carbon off them, cleaning them finally and nicely with a stiff toothbrush dipped in petrol.

Sparking Plug Holders.

110 When testing the spark at a set of exposed sparking plugs, most motorists feel the need of special clips to grip the plugs, which have a habit of tumbling out of contact, more particularly when single plugs are being tested with the engine running. Under these circumstances, too, there is a risk of straining the magneto or coil if a plug

swing by its wire without any earth contact. An ordinary cycle pump clip of the double "U" spring type makes an excellent plug holder. One end may be sprung over any convenient pipe or bolt or stay, and the inverted plug dropped in the empty end.—B.H.D.

Multi-point Ignition with Single-pole Plugs.

111 The subject of multi-point ignition is one that is causing a great deal of interest at the present time, and the following suggestion and diagram of a method of adapting this to single-cylinder engines without the aid of double pole plugs, or specially formed cylinder head, has been forwarded to us by Messrs. Lodge Bros., Ltd., whose double pole plugs have brought multi-point ignition into prominence.

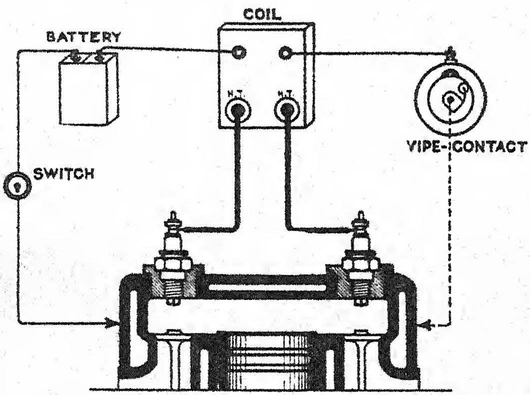


DIAGRAM SHOWING TWO ORDINARY PLUGS IN SERIES.

It must be pointed out that the hint can only be adopted in cases where accumulator ignition is used and the induction coil has two exterior high-tension terminals. In the usual course one of these terminals is connected with an "earth" wire, or sometimes with a brass band which holds the coil in position and also conveys the "earth" circuit from the coil to the frame. The Lodge coils are always supplied with these two exterior terminals, as are many other makes well known and largely used.

The earth wire or connection should be removed from the second terminal, and an additional high-tension wire affixed thereto, this wire being carried to a second sparking plug screwed into any convenient point in the cylinder head, preferably, as shown, into the valve cap on the opposite side of the engine to the original sparking plug—for it should be borne in mind that the passage of the ignited gas being equally free, the further apart the two points of ignition are the better.

The diagram shows a suggested method for wiring up the low-tension circuit as well, but this need not necessarily be followed or the existing low-tension wiring touched.

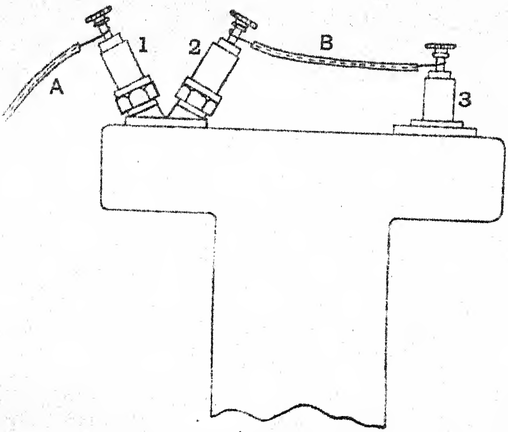
It is pointed out by Messrs. Lodge Bros. that, although it is probable that this second high-tension terminal is not so well insulated as that to which the single sparking plug is connected, yet there would be sufficient insulation for the purpose of using two plugs in series in this way.

The second terminal which it is thus suggested should be taken advantage of is simply the other end of the secondary winding to that connected with the usual H.T. wire, and in coils where it is not exposed in this way the low-tension circuit is made use of to carry the H.T. earth circuit usually by way of the contact breaker.

Two Simultaneous Sparks in a Cylinder.

112 Where high-tension magneto ignition is fitted to an engine having its exhaust valves and inlet valves on opposite sides of the cylinders, it is possible to arrange for two simultaneous sparks to take place on the firing stroke in each cylinder with advantage in the matter of more economical running and increased power in the engine, particularly at high engine speeds. The necessary alteration is trifling. It is only necessary to replace the inlet valve caps by others on which are cast two bosses, each boss bored and tapped to take a plug. To these new caps are fitted single pole sparking plugs, the points thereof being adjusted (after the plugs have been screwed into place in the cap) to give the usual spark gap. The new caps, with the single pole plugs in position, are then screwed into their places over the inlet valves. The high-tension wires from the magneto, instead of being connected direct to the plugs in the ordinary way, are connected to the single pole plugs, one, of course, to each cylinder. The remaining four single pole plugs are then connected across the cylinder to the ordinary sparking plug, thereby wiring the three plugs on each cylinder in series. The current passes from the wire A to plug No. 1, across the gap to plug No. 2, and then passes

through B to plug No. 3, which is an ordinary plug. Experiments have been made and it has been found that higher efficiency is obtained by having two simultaneous sparks than with the single spark, as it slightly accelerates the propagation of the explosion in the cylinder, besides making it more positive. In the case of an engine with all its valves on one side, the advantage of the simultaneous sparks would probably be less pronounced, although there would still be some gain, especi-

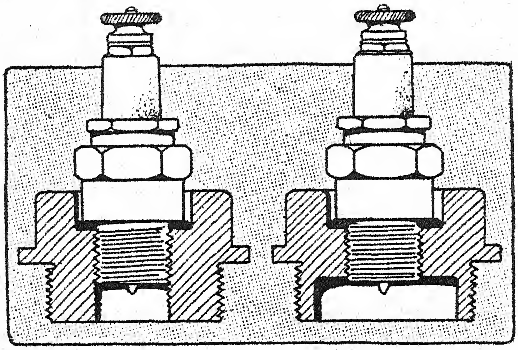


ally at very slow and very high engine speeds. It may be argued, as the spark passes between the points of plugs 1 and 2 before it proceeds to jump the gap of plug 3, that the sparks are not simultaneous. It is true that they are not so, but the speed of the current is 186,000 miles per second, so that it is obvious that this speed is immensely greater than the speed of the flame propagation, rapid though that be; the infinitesimal difference between the timing of the two sparks may therefore be ignored.

Spare Ignition Sparking Plugs.

113 In engines having the valves on opposite sides and fitted with two ignitions—the sparking plugs for the spare ignition being on the exhaust valve side—it is sometimes found that the spare ignition will not fire so regularly, nor is the engine so powerful as when the magneto ignition, operating through sparking plugs situated on the inlet valve side, is used.

It is generally found that better results can be obtained from the spare ignition by enlarging the hole through the valve caps on the exhaust side, as shown in the right-hand sketch, so that the sparking plug points are not set in such a narrow and deep pocket as often obtains. The sketch given herewith shows a valve cap with a long narrow hole, and also one in which the bore of the hole has been considerably enlarged at one end to allow the mixture more easily to reach the sparking plug, and so ensure more rapid combustion. The same ends can sometimes be attained by the use of a special set of sparking plugs, the points of which will extend more nearly into the combustion space proper.



The failure sometimes experienced with a spare coil ignition to start "on the switch" is very often due to the same cause, for there being practically no compression when the engine is at rest the mixture will not approach the sparking plug points sufficiently to ignite the charge when the sparking plugs are set in deep pockets. This applies to both sides of the engines, both inlet and exhaust, but more particularly the latter. Another trouble sometimes experienced with sparking plugs set on the exhaust valve side is more often apparent when the plugs are set in deep pockets. We refer to the sooting up of the points and their becoming fouled with burnt oil deposits when the ignition is not in use. This trouble is far less likely to be experienced when the points of the plugs are closely adjacent to the combustion space, for the combustion of the gases brought about by the other ignition will then tend to burn away any deposit which may occur on the sparking plugs not in use.

To Prevent the Fouling of Sparking Plugs.

114 Until the lubrication needs of some engines are mastered, sooted plugs are frequent, and an account of the way in which this tendency may be combated should interest many novices. If a long-nosed plug be used, the evil may be overcome by threading two or three ordinary sparking plug washers on each plug, in lieu of the standard single washer, always provided that the thread is long enough for the purpose; at least four threads should project beyond the washers. The effect of fitting several washers is to raise the plug higher in its orifice, so that less oil is deposited on its business end. The writer actually uses short metal collars, threaded externally at their lower extremity to fit the engine, and externally at their upper ends to carry the sparking plugs. The scheme recommended naturally reduces the compression ratio of the engine a trifle, but the loss is not greatly appreciable. It also retards the timing slightly.

A Strange Cause of Misfiring.

115 My engine is fitted with both magneto and accumulator ignition, and I was recently worried by a spell of misfiring when the latter system was in use. The accumulator ignition consists of a Guenet coil with dry cells, giving over eight amperes and more than four volts. The same sparking plugs are used for both ignitions, and these were set with a spark gap of about seventeen to twenty thousandths of an inch. Ultimately I traced the cause of the trouble to the fact that the accumulator system required a gap at the sparking plugs of at least twenty-five thousandths, for when I increased the width the misfiring at once ceased, nothing else being changed in the course of the final experiment, which resulted successfully. So many magneto plugs with short gaps are now used for both ignitions that this may be a frequent cause in the other obscure cases of misfiring when the accumulator system is in use.—D.M.

A Remedy for a Coil Ailment.

116 If a coil gives trouble on the road, it usually presents a more or less insurmountable difficulty, but a hint worth trying under such circumstances is that once given by a driver of a commercial vehicle in *Motor Traction.* In this instance the driver traced a roadside trouble to the coil, and, knowing that in some coils the + terminal was internally directly connected with the bridge piece, he put a wire across between the bridge piece and positive terminal, and found

that by these means the missing spark was restored. He accordingly maintained the wire in that position, and, in fact, has done so ever since, as he prefers an accessible external connection to an inaccessible internal one, however neat. The remedy may be fairly obvious, but then it is exactly the obvious that clever people are apt to overlook.

Misfiring on Sleeve Valve Engines.

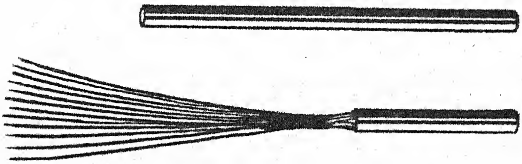
117 Occasionally a slide valve engine will misfire, but, notwithstanding when details are examined, everything will be found apparently all right. For instance, although the engine may have misfired on the road, it will be found that each cylinder will run quite well independently when the other three plugs are cut out. This, of course, proves there is nothing wrong with the magneto, plugs, or wiring; but despite this fact the misfiring may persist. Under these conditions it will usually be found that the trouble is due to the pocketing of the sparking plugs. It will be remembered that in slide valve engines the plugs are in deep pockets, and if the plugs happen to be at all short the plug terminals are little, if any, above the annular tops of the cylinders. It follows, therefore, that the ends of one or more of the high-tension wires where they are fitted to the plug terminals may be so close to the top of the cylinder that when running on the road the vibration may cause the metal terminal of the wire to short to the cylinder head, despite the fact that when run light no short would occur, and the engine would fire in all the cylinders without missing. Of course, the remedy is perfectly simple. It is merely necessary to bend up the end of the wire so that there is a good clearance between it and the cylinder top or the nearest metallic part.

CARBURETTERS.

CLEANING CARBURETTER JETS.—CHOKED CARBURETTER JETS. —CHOKED JET: OBSTRUCTION OUT OF LINE OF VISION. —RACING ENGINE TO CLEAR BLOCKED JET.—BAD CLIMBING.—TESTING PETROL LEVELS.—CARBURETTER UNIONS. —THE FREEZING OF CARBURETTERS.—FLOODING CARBURETTERS AND PUNCTURED FLOATS.—MORE AIR.—AN EXTRA AIR VALVE.—AUTOMATIC AIR VALVES.—ELUSIVE KNOCK AFTER FITTING NEW CARBURETTER.—CARBURETTER ADJUSTMENTS.

Cleaning Carburetter Jets.

118 A handy little tool for clearing carburetter jets may be made from a short length of Bowden brake cable strand as used on bicycles. The end will probably be found to be soft soldered to prevent the wires from flying apart. Solder again 3in. or 4in. from the end, and then cut



off below the soldering, so that the wires will fly apart. The original soldered end will now become a handle, and the wires provide a number of flexible needles which can be threaded from underneath the carburetter, even in a confined space in which it would be quite impossible to use a rigid wire.

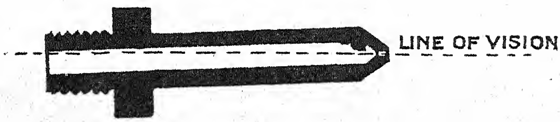
Choked Carburetter Jets.

119 One of the most exasperating of minor troubles which can fall to the lot of the motorist is to have a partially choked petrol jet in the carburetter. If the jet were wholly blocked up and the engine could not be run at all, one would naturally go to the carburetter (if not at once, directly after testing the ignition), and the cause of the trouble would be revealed. On the other hand, when there are particles of foreign matter floating about, they will keep more or less clear of the jet, but they are never far away. You

flood the carburetter and start up the engine, which runs merrily for a few revolutions, coughs, chokes, and stops. What has happened? Those free bits of dust, which were merely agitated by the action of flooding the carburetter, have, by the constant suck exerted by the engine, been drawn up into the jet and effectually blocked it. The engine being stopped, the bits fall away from the jet again, and so the process of numberless startings up of the engine is performed. Now, if the ignition be found in order, and the petrol feed to the carburetter be clear, it is nearly always advisable to proceed to the jet and clear it out straight away. Whilst the jet is out, run some petrol through the jet orifice to wash away any particles which may be left behind. The jet being clear, it may be replaced and flooded, in order to ascertain that all is perfectly in order.

Choked Jet: Obstruction out of Line of Vision.

120 On the subject of carburetters, I wonder how often a series of annoying stops following quickly upon one another have been brought about by such a cause as in a case I came across recently.



I was chatting with a fellow motorist in a garage where I was taking in petrol, and he told me that his car was at that moment being attended to in order that a carburetter trouble might be put right. He said that all the symptoms pointed to a choked jet, but that he had failed himself to find the offending atom, either in the jet or in the body of the carburetter. He had been pulled up on the road several times, and had only just managed to crawl into the garage.

Whilst we were talking the mechanic had taken the carburetter down and to pieces. He examined the jet, etc., and declared all clear; the owner of the car also examined it again, but failed to detect any possible cause of obstruction. However, a third individual who was standing by (modesty forbids me to mention his name) was sufficiently curious to peer through the jet too, holding it up towards the light and examining it from both ends. There *was* something in it! Not in a direct line of vision, but " round the corner," so to

speak. A carburetter jet, perhaps you have noticed, has, or the majority have, a comparatively large bore for the greater part of its length, the small diameter which regulates the flow of the petrol extending for about ⅛in. only. The two bores merge into one another by a taper formed by the tip of the drill used for making the large bore, and if you will examine the sketch herewith you will see how it is possible for a piece of grit or waste to escape notice unless care is taken when searching for some obstruction.

In the instance under notice there is no doubt that when the engine was pulling and using a large flow of petrol the offending atom would move out into the smaller bore, receding again when the engine was throttled down, and remaining so when the carburetter was emptied for examination. But apart from all theories as to what happened when the engine was running, there was the cause of the bother without doubt.

Racing Engine to Clear Blocked Jet.

121 Every motorist knows the recipe for clearing a blocked jet, which in nine cases ont of ten is successful. We mean the holding out of the clutch and the racing of the engine for a few seconds, so as to put a strong suction upon the jet, thereby removing the obstruction. This, of course, can only be employed when some petrol comes through, so that the engine can be run, for very often a partial stoppage, which is quite sufficient to prevent the car pulling properly, will not be serious enough to prevent the engine being run light. While, as we have said, this little dodge of racing the engine is so well known, there is a natural development of it which many motorists forget. The object of the engine racing is to place a strong suction on the jet, and in all carburetters which have extra air inlets, either automatic or hand controlled, it should be borne in mind that these inlets should be closed, as then the suction on the jet is strengthened. No hard and fast rules can be given, because the designs and details of carburetters vary so much, but the principle will be grasped if we say that with a carburetter which has an automatic air inlet—in other words, a spring extra air valve—the engine should be run with the valve in its normal condition, but directly the engine has begun to race the valve should be held shut. The mere shutting of it when the engine is going fast puts a tremendous suction on the jet, and will probably bring out the obstruction. Most engines choke themselves with petrol when they are run fast with the extra air held closed, but there is no fear of this for a considerable

number of revolutions, and unless the obstruction be very bad the tremendous suction imposed upon the jet will probably bring out the dirt. Of course, much the best way is to take the jet out and clear it, but there are hundreds, nay, thousands, of cars on the road in which it is impossible to remove the jet without taking down the carburetter, and nine carburetters out of ten are not easily taken down. In the first place, they are not accessible, and in the second, to take them down means undoing the petrol and water unions, thus on cars which have no taps to the pipes leading to the carburetter water jacket most of the water is lost. It seems almost incredible that cars should be built like this, but numbers have actually been turned out during the past year or so with the grave deficiencies we have mentioned. In theory, with a good filter there should be no such thing as a blocked jet, but even with the finest meshes small pieces of foreign matter pass into the carburetter, and in the course of time agglomerate in some way and form a sort of mud, which sooner or later may block the jet.

Bad Climbing.

122 Sometimes a car with a gravity fed carburetter will climb very badly—possibly even stop on a hill which in the ordinary way it takes quite easily. The symptoms are unquestionably carburetter, and one at once agitates the float. Probably by the time this has been done the engine starts quite easily, and takes the rest of the hill without bother. The motorist thinks that his float has stuck, and it may be that it has. However, after he has satisfied himself that there is nothing wrong in this quarter, it is quite likely the car will repeat its bad behaviour further on ; then possibly it will recover, and there will be no more trouble. The next time the same road is covered the car will take the hills which it has jibbed upon the previous occasion without the least hitch or falter. This sort of thing may go on for quite a long time, and the automobilist may not be able to find any good reason for it. We have come across several cases of this kind, and we must confess they were very puzzling to us, but as we narrowed down the possible causes we came to examine the differences of level between the petrol tank and the float chamber. In one particular case we found the difference very slight indeed, and we then purposely took the car to a rather steep hill with only a little over two gallons of petrol in the tank. It failed at once, and we found the float chamber nearly empty. After waiting for a moment the petrol trickled

in, and the engine was started again. We then turned round and went to the bottom of the hill and filled the tank right up. The car then took the hill flying, and we saw at once that what we had put down to sluggishness of the float or to a partially blocked petrol pipe was simply due to the fact that this particular car would not climb well except when the tank was nearly full. As one cannot guarantee to encounter all hills with a nearly full tank, we rectified the matter by fitting a back pressure valve and an air pump to the petrol tank, of course stopping up the air vent in the filling plug. This has completely cured the trouble, and the remedy is much simpler than attempting to raise the tank or lower the carburetter.

Testing Petrol Levels.

123 It is commonly supposed that if there is a slight "blob" of petrol upon the top of the jet the petrol level is about right. As a matter of fact, this is really no guide, as owing to the extreme smallness of the hole through which the petrol issues, capillary action is set up. Of course in the ordinary way, there is no need to bother about the petrol level. If the engine is running well, and the fuel consumption not excessive, it is better to leave things alone; but if there is any necessity to test the petrol level, the right way to do it is with an open pipe, and not the jet. To all intents and purposes an ordinary jet is a pipe which is stopped, as the orifice is so small. The thing to do is to obtain a spare jet and to bore it out as large as possible without cracking the sides of the jet tube. The petrol will then stand at its natural level in it, and one can see exactly what that level is.

Carburetter Unions.

124 When a petrol feed pipe has been uncoupled for cleansing, some difficulty will occasionally be encountered in replacing it, especially if the nuts be inverted and slightly inaccessible. It will be found of great advantage to turn the first thread (or even two threads) off both nut and shoulder, to ensure accurate centring of the joint before a spanner is applied. Should the union leak a little on the road, the cone should be held tight against its shoulder, and the inside of the nut plentifully smeared with common soap. The nut may then be pushed up over the cone and locked, when the leakage will be found to have ceased. These unions are usually made of soft metal, and to avoid straining them.

it is essential to give the nut at each end of the pipe a turn apiece in order, instead of first tightening one end and then forcing the other end into engagement.

The Freezing of Carburetters.

125 During a snap of frost, we had an experience with one of our cars which may prove a warning to others. While the cooling water circulating system was in a sufficiently warm place to prevent its freezing up, yet it did not protect the carburetter from the effects of the frost. This particular carburetter has a hot water jacket around the mixing chamber, which is in close proximity to the float feed chamber. A single tap is provided to prevent the water circulating round the jacket when extra heat is not required, but it was impossible to drain the water from the jacket. The low position of the carburetter, and the lower temperature occasioned by the near presenee of petrol, were too much for the water around the carburetter, and it froze up. A natural consequence was that something had to go, and, fortunately, the weak spot was found at a plate soldered over a clearing hole in the water jacket. This gave way, and when the thaw came we had a fountain display beneath our engine bonnet. As a protection against similar occurrences, we had an extra tap put into the circulation pipes on the other side of the carburetter, and a drain tap put into the lowest point.

Flooding Carburetters and Punctured Floats.

126 The process of flooding a carburetter is not one that on first thought would call for a warning or advisory note ; but so many complaints are heard from time to time of leaking floats that it is well to remember that this trouble can very easily be brought about by carelessness or rough handling when flooding the float chamber to ensure a ready start. Many users of cars appear to possess the idea that the process referred to must necessarily have the effect of causing a fountain of petrol to issue from the jet ; and with this idea in view the float, by the operation of the protruding end of the needle valve, is jerked violently up and down. This violence, which is quite unnecessary, must in time have the effect of damaging that fragile detail the float, followed by heavy consumption of petrol, loss of power, overheating, and other troubles. The violence, even to a slight extent, is unnecessary, because the same temporary excess of petrol, which is sometimes required to start an engine easily, can be obtained by merely lifting the needle valve, and so depress-

ing the float when toggles are included in the design, or depressing the valve when float and valve are directly coupled.

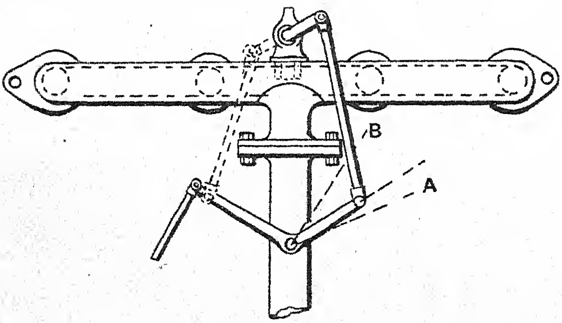
There is no advantage under starting conditions in causing a spray or fountain of petrol to issue from the jet. All that is required is that the level of the spirit shall be such that it will overflow from the jet into the mixing chamber.

When persistent flooding occurs, it is generally due to one of two things: Failure of the needle valve to seat properly, which can, of course, be overcome by grinding-in the valve, or to a punctured float, which allows a small quantity of petrol to enter, and thus upset the balance and allow the petrol level to rise higher than it should do, and consequently to flood. This can be easily discovered by shaking the float, when the liquid can be heard inside. To find the hole and get the petrol out is somewhat difficult, but the following is the simplest way: The float should be put into very hot water and held beneath the surface. The heat causes the petrol to gasify and be driven out through the small hole, when the issuing bubbles will make it clear where the hole is. The float should be thoroughly cleared of petrol, and the hole stopped up with solder. In doing this it is a mistake to put as little solder as possible on to the hole, but the job should be done thoroughly and be cleared afterwards with fine emery paper. Of course, care must be taken not to allow too much solder to remain on, so as to upset the balance of the float, and not to allow the solder to get into the float. Silver solder is better than soft solder for this purpose. If after the hole has been closed a slight leakage follows which it is impossible to locate, a good method of preventing further trouble is to give the whole float a good coating of nickel by electro-plating it. This closes up the small porosities better than any solder will do.

More Air.

127 There is no doubt that many motor cars are wasting a lot of petrol simply because the carburetters do not supply sufficient air. It is not merely a question of economy of petrol, though that is quite an item nowadays, but in many cases more power can be obtained from the engine, and it keeps much cleaner, while the valves keep cooler, and the smell from the exhaust is much less if a weak mixture is used. There are many ways of increasing the air supply, but certainly nothing simpler than the little device which Mr. Garrard fitted to the Talbot cars. These cars have a carburetter with a very sensitive and easily adjusted automatic

air valve, which, in its way, is an excellent thing. At the same time, it is admitted that with an automatic extra air inlet it is very difficult to get absolutely perfect working. That is to say, if the plunger and the spring adjustment, or device for controlling the extra air inlet, be adjusted for one speed, it is not necessarily correct for all speeds, although it may be approximately so. Mr. Garrard's device is simplicity itself. A small air tap is screwed into the centre of the induction pipe, with a maximum opening of about 8 mm. This tap has a lever connected either as shown by the full lines or the dotted lines to an extension of the throttle lever or to a ball joint fitted to the throttle lever itself, as depicted by the dotted lines to the left hand. The rod connectingthe throttle lever and the tap should preferably consist of a tube fitted with a small lug, such as is used in bicycle brakework, so that the upper end of the connection can be slid inside the tube, and accurate lengthening of the rod relative to the throttle lever be made.

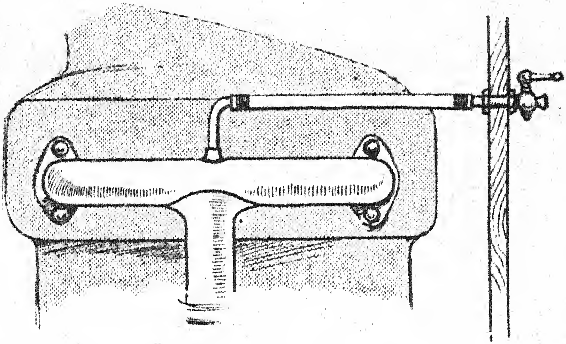


The method of fitting the double extra air inlet tap. The letters A B indicate the limits of motion to the tap.

The adjustment of the rod length is effected so that the throttle lever may be moved through an angle of about 8° before the tap is opened at all. Then any further movement of the throttle lever begins to open the tap, and thus allows outside air to pass into the induction pipe, where it mixes with the vapour from the carburetter. When the throttle lever is about three parts open the full opening of the tap is obtained, and this full opening is maintained until the throttle lever is open to its extreme. It will be thus seen that, in addition to the automatic air valve extra air supply, a further amount of air is allowed through the tap.

An Extra Air Valve.

128 Mr. Louis W. Jelf-Petit writes: "A piece of ¼in. copper tube is soldered with a good shoulder on to any convenient place on the induction pipe—I find in practice the nearer the induction valve the better—connected by india-



rubber tubing to what is technically called an 'urn tap' placed on the dashboard in a position convenient to the left foot. On the running of one car in particular it has had a most remarkable effect, and may be regulated by the foot to a nicety."

Automatic Air Valves.

129 Many carburetters still depend upon automatic air valves for their satisfactory working. That is to say, a certain fixed amount of air is always admitted beneath or across the jet, and then there is some arrangement of spring-controlled air valve, which is sucked open as the speed of the engine increases. Of course, there are plenty of carburetters in which the additional air is provided positively by some inter-connection with the throttle, but at the moment we are not discussing this type. Properly adjusted, the automatic carburetter of the spring-controlled type is most satisfactory, provided always that the spring-controlled valve is really well made and so designed that when it is shut it is not leaking. There are not many variations of this type of automatic air regulator, and all the best have some form of atmospheric buffer or its equivalent to prevent too sudden an action of the valve. The majority of users of automatic carburetters, however, do not realise how very much depends upon their free and smooth working. A good many of the mysterious

losses of speed and lack of life, particularly the latter, are simply due to sluggishness in the opening and closing of the spring-controlled air valve.

What is not realised is that the proper sympathetic opening of this extra air inlet as the speed of the engine increases is essential to a quick pick up. When the valve is closed the engine speed is low; but if, on the opening of the throttle, the extra suction of the engine does not instantly commence to open the extra air supply, the engine will only respond sluggishly, for the simple reason that it is being more or less choked with too rich a mixture. As soon as the speed gets up, the sluggishness of the air admission will automatically check itself, as the suction of the engine will become so strong that the air valve is, as it were, dragged open. At the other end of the scale, if it closes sluggishly, there will be pops back into the carburetter. At least once a week the automatic air valve should be taken out and carefully examined. It should be cleaned, and it should be seen that the valve is perfectly free. Most of the air valves slide on some form of central stem, with a spring to keep them in position, and all the moving parts should be most carefully cleaned. It will very often be found, on pushing the air piston up and down, it is not quite free. It can hardly be said to hang, but there is just a suspicion of a hitch in its action.

It is not enough to see that there is no dust on the valve and its connections, and the best way we know to put everything in perfect order is to clean all the working surfaces with brass polish. This alone will often make a difference between a sluggish engine and one which dances away in instant response to the throttle. If one wishes to gild refined gold, still better results will be obtained by blackleading the edges of the valve and the guide or stem on which it works, and it is equally important that the buffer piston, if an air dashpot be fitted, be carefully cleaned and polished too. It should be clearly understood that no emery should be used, otherwise air leaks will be set up. All that is wanted is perfectly smooth surfaces, so that the valve can respond instantly to the varying degrees of suction to which it is subjected.

If, after this attention, the car is not lively, or if the engine pops back in the carburetter, it is evident that the spring of the automatic valve requires adjustment. Speaking generally, sluggishness of pick-up shows that the spring is too strong, so that the air valve does not open soon enough. If popping back in the carburetter takes place when the car is running at a moderate speed, and without any sudden

closing of the throttle to provoke it, it may be taken as a certain indication that the spring is too weak, so that the air valve opens prematurely and weakens the mixture too much at low or very moderate engine speeds.

Elusive Knock after Fitting New Carburetter.

130 Recently one of our readers who had fitted a new carburetter to his engine was somewhat disappointed to find that, while he had improved the petrol consumption and the general running of his engine, it knocked rather badly, although not sufficiently to diminish power noticeably. This experience brings up a point which is not always recognised, and that is, any considerable change in carburation will often necessitate some alteration in the timing of the ignition. To take a case in point, we will assume that a car has been sent out with the carburetter adjusted so that it delivers too rich a mixture This richness may occur at low speeds only, or it may be all through the scale ; or the carburetter may be adjusted so that the engine will run without knock when pulling slowly with the ignition retarded. All sorts of unexpected things may happen when the owner sets about effecting improvement either by readjusting the carburetter or by fitting a new and better one. For instance, if the old carburetter provided too rich a mixture at all speeds the chances are that the new one will cause the engine to knock badly at all speeds ; but if the old carburetter only gave an unduly rich mixture at low speeds no alteration of the permanent ignition timing may be required, as there will be no knock except, perhaps, at the very lowest speeds, when no doubt the ignition can be sufficiently retarded to overcome the trouble. Even the most efficient carburetters are more satisfactory for starting and slow running if they provide a mixture which is on the rich side at low speeds.

The reason for this knocking when carburation is improved is due to the fact that a needlessly rich mixture is a slow burning mixture, and consequently the ignition must necessarily be more advanced under such a condition than would be the case if the carburetter were providing an approximately correct mixture. We have referred to the cause of knock as elusive, as if the ignition were right before the carburation was improved or a new carburetter fitted it is natural for the motorist to search in almost every other direction for the cause, for he assumes that if the timing were correct before the change, and had not been altered, it cannot be the cause of the knock.

Carburetter Adjustments.

131 The adjustment of a carburetter is not difficult if attacked in a proper manner. The usual plan of altering the size of jet, choke tube, etc., without method generally results in failure and a return to the original setting, which has probably been arrived at in the same haphazard manner.

A good rule is to make only one alteration between each test, and never to make an alteration without first having a clear idea as to what effect it will have on the running of the engine.

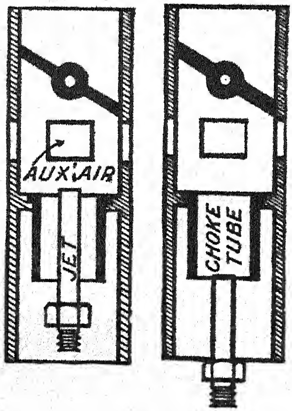
There are three essential parts in the usual design of carburetter: (1) A jet supplied with petrol at a constant level, (2) a restriction in the bore of the air intake (generally termed a choke tube), and (3) a variable air intake controlled either by hand or automatically (usually termed the auxiliary air inlet).

The Choke Tube.

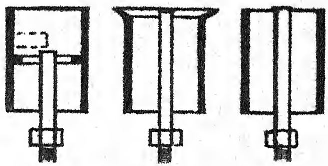
The function of the choke tube is to offer resistance to the air entering the carburetter, so as to create the necessary difference in pressure between the petrol in the float chamber and that in the jet, although a common error is the supposition that the high velocity of the air past the jet sucks up the petrol. The petrol in the float chamber is constantly under the influence of the pressure of the atmosphere (14.7 lbs. to the square inch), and when the engine is not running the petrol in the jet is also subjected to the same pressure; hence there is no flow. When the engine is running the throttling back of the air entering the carburetter by means of the choke tube or its equivalent causes the pressure in the jet chamber to be lower than that of the atmosphere; therefore the atmospheric pressure in the float chamber forces the petrol through the jet. The flow is thus governed by the difference in pressure between the inside and outside of the carburetter, and this difference in pressure is governed by the resistance the choke tube offers to the incoming air—not necessarily the size of choke tube, for holes of certain shapes offer more resistance to the air passing through them than others, and may vary as much as 50% for the same area. There is no advantage in making choke tubes of any special shape for the more easy passage of the air, for it only means that the hole will have to be made smaller to obtain the required resistance.

Fig. 1 shows diagrammatically the correct disposition of the choke tube in relation to the jet, although a very usual

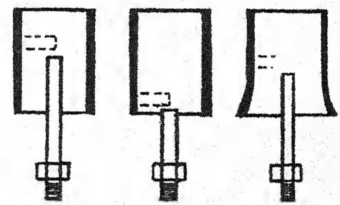
design is that shown in fig. 2, where the jet is at the lower outside end of the choke tube. It will be apparent that with the choke tube and jet arranged as in the latter sketch, although varying but slightly from the method shown in fig. 1, the conditions of working are very different. In fig. 2 the jet is not in the most advantageous place as regards the partial vacuum in the carburetter. Any resistance in the bore between the jet and the engine (such as the length of choke tube from the tip of the jet to the inside of the carburetter, fig. 2) is detrimental, for it restricts the supply of gas at high speeds to a small extent.



Figs. 1 and 2.



Figs. 3, 4, and 5.



Figs. 6, 7, and 8.

It is almost impossible to make an engine run steadily at low speeds with the position of jet and choke tube shown in fig. 2. The difference in pressure between that acting on the petrol in the float chamber and that in the jet is so small that the slightest irregularity in the speed of the engine will upset the mixture.

In figs. 3, 4, and 5 are shown a number of choke tubes and jets arranged in satisfactory position. Figs. 6, 7, and 8 illustrate alternate arrangements which are not recommended. An alternative position of the jets, shown in dotted lines, illustrates the arrangement when the jets and choke tubes are at right angles to each other—the former vertical and the latter horizontal.

The Auxiliary Air Intake.

The mixture does not enter the engine in a steady stream but is in a rapid state of oscillation set up by the uneven suction of the engine, and these oscillations may vary from four to forty per second with the lowest to the highest speed of the engine, having a peculiar and varying effect on the air and petrol entering the carburetter. The elasticity of the air prevents it following up the rapid movements of the pistons at high speeds, and it was proved some years ago with a single-cylinder engine running from 150 to 1,500 r.p.m. that the quantity of mixture taken in at the highest speed was as much as 50% less than the piston displacement, this being due to the elasticity and inertia of the air. Petrol is comparatively heavy and non-elastic, and each beat of the engine adds to its momentum, until it issues from the jet in a steady stream. The air, however, has a tendency to decrease proportionately as the speed rises, which results in too rich a mixture if provision be not made for checking this.

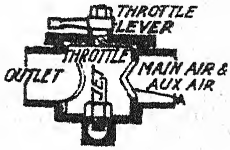


Fig. 9.

The most usual method of obtaining an approximately correct mixture is to provide an additional air opening adjustable either by hand or automatically controlled. This opening is generally termed an "extra air inlet," but the term is a misnomer, for as an engine only takes in from 50% to 75% of a full charge at high speeds, the proportion of air taken in diminishes as the speed of the engine rises. The real purpose of this additional air intake is to vary and regulate the resistance offered to the air entering the carburetter by increasing or decreasing the area of the intake, and, as pointed out under the heading of "The Choke Tube," the resistance offered to the air entering the carburetter governs the pressure tending to force the petrol through the jet. Therefore the greater the opening provided for the air to enter the carburetter the less will be the resistance and the smaller the difference in pressure between the inside and outside of the carburetter; consequently less petrol will be forced through the jet.

It would be manifest that if the choke tube were made adjustable it would answer exactly the same purpose as the auxiliary air opening; in fact, this is the principle adopted in some carburetters, of which fig. 9 is a diagrammatic sketch.

In this case A is really a choke plate, but its purpose is the same as a choke tube, *i.e.*, to offer resistance to the incoming air.

The control of the auxiliary air opening by hand has many drawbacks, and at the best only a rough approximation to a correct mixture is possible in this way. It is practically impossible to follow every variation of speed by a corresponding movement of the air lever. Various automatic devices are in use to open the auxiliary air port as the speed of the engine increases, but two only of these will be described. Seventy-five per cent. of present day carburetters are fitted with either one or the other system.

Auxiliary Air Inlets.

The first and most popular is that generally termed an automatic air valve, which consists of a spring-controlled valve sometimes after the style of an automatic inlet valve and alternatively in the form of a piston arrangement. Both depend for their action on the suction of the engine, and act in keeping the pressure in the inlet pipe normal, just as a safety valve on a boiler prevents the rise of steam pressure beyond a certain point. It is sometimes urged against the use of these valves that the mixture must necessarily be on the rich side at high speed, but the writer has in practice found this theory to be without foundation, for the pulsating action of the engine has the same peculiar effect on a valve of this class, due to inertia, that it has on the petrol flow. The valve at low speeds simply vibrates on its seat, and offers a greater resistance to the air entering than at high speeds. In effect the inertia is equivalent to increasing the tension on the spring at low speeds.

As the speed of the engine should increase with the opening of the throttle and a greater air opening is also required with increased speed, in some designs of carburetters the auxiliary air port and the throttle have been arranged to open simultaneously. Fig. 10 shows the usual arrangement. Designers of this pattern of carburetter overlook the fact that the amount of auxiliary air opening should be proportionate to the speed of the engine and not to the position of the throttle, for the opening of the latter must always precede the speed of the engine. Therefore, if the throttle on this type of carburetter be suddenly opened with a view to rapid acceleration, the petrol flow stops or diminishes to such an extent, due to the momentary destruction of the partial vacuum in the jet chamber, that the engine will not pick up, or will stop altogether.

To make the working of this type at all possible it is absolutely necessary to make the auxiliary air opening smaller than the best size for economical running. To illustrate this, suppose that an engine is running under load at 800 r.p.m., and the throttle is suddenly opened to a point that has been found to run the engine at, say, 1,000 r.p.m. on the same load, then if the engine will reach this higher speed without faltering, the larger air opening is the right size for the lower speed position only. It is therefore usual in practice to sacrifice a little efficiency and operate this pattern of carburetter with a smaller auxiliary air opening than that which would give the most economical running. The difficulty may be overcome in a very simple manner by enlarging the size of the air port and clamping or soldering over this a spring-controlled air valve as shown in the dotted lines in fig. 10. With this arrangement the correct amount of air is automatically admitted without upsetting the mixture when accelerating quickly.

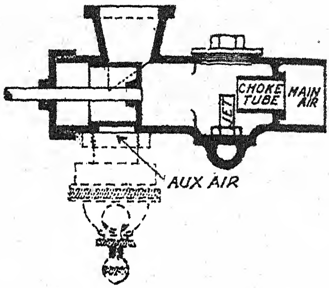


FIG. 10.

SPEED AND SLOW-RUNNING ADJUSTMENTS.

The conditions for speed and slow running being diametrically opposite, a compromise must be made in adjusting a carburetter. For power at high engine speeds a large choke tube, together with a large jet, is desirable in order not to throttle the supply of gas to the engine. For handiness in traffic and slow-speed running with power a small choke tube is required to maintain sufficient difference in pressure between the inside and outside of the carburetter. A small jet would also be required to keep down the petrol consumption at high speeds, as the petrol would issue at a greater velocity. The diameter of the hole in the jet will not of itself govern the quantity of petrol delivered; this depends also upon the pressure ratio. The writer has come across cars of about the same cylinder dimensions having a variation in jet diameter of quite 2 to 1, each giving good results and having approximately the same petrol consumption. The larger jets, with, of course, a larger choke tube, while giving fairly good all-round results gave far less flexibility than the smaller jets with

smaller choke tubes. In the case of the engines fitted with the larger choke tubes the carburetters were working with a very small difference in pressure between that acting on the petrol in the jet and that in the float chamber. In the case of the smaller jet and choke tube the pressure ratio was much greater at low speeds, and therefore less sensitive to any change tending to upset the mixture. Of course, there is a practical limit to the smallness of the choke tube and jet. The smaller the choke tube the greater will be the call upon the auxiliary air supply, and if this be hand controlled, it will necessitate more frequent adjustment to obtain the best and most economical results, but if the auxiliary air supply be taken care of automatically by means of a spring-controlled valve or other device, the choke tube may be reduced to a convenient size for slow running, as it need only pass sufficient air to break up and convey the petrol spray into the auxiliary air supply.

At first sight it might appear that a small choke tube would greatly interfere with the engine getting a full supply of gas at top speed. While this is certainly true to a slight extent, and might be detrimental to the running of a car used for track racing, its effect on an ordinary touring car is so small that it is difficult to detect any falling off in the maximum speed of the car.

HOW TO GET THE BEST RESULTS FROM AN OLD CARBURETTER.

The following are a few practical hints on how to get the best results from an old single jet carburetter. The most usual faults are want of flexibility, high petrol consumption, and difficulty in starting. The want of flexibility is due to the difference in pressure between the inside and outside of the carburetter being too small at low speeds, and therefore very susceptible to any variation of engine speed. This defect may result from air leaking into the inlet system, too large a choke tube, or a choke tube fitted in a very inefficient position; another cause may be that the petrol level is too low in the jet.

Any leakage of air into the inlet system either through the joints, the throttle, or by way of the inlet valve guides will have a detrimental effect upon slow running. The first thing, therefore, is to see that all the inlet pipe joints are well packed and reduce the leakage of air into the inlet system, other than by its proper course, to a minimum. Now check the petrol level in the jet. This should never be lower than $\frac{1}{8}$in. from the top of the jet or higher than $\frac{1}{16}$in. below the top.

CARBURETTERS. (131 *continued.*)

It is a difficult matter to gauge the height of petrol in a single jet through the small hole, and this difficulty is accentuated by capillary action. It is therefore advisable to construct a dummy jet, out of a spare jet, for instance, by sawing this off about $\frac{1}{2}$in. from the top and soldering on a piece of tube at least $\frac{1}{4}$in. inside diameter. The dummy and the working jet should measure the same from under the shoulder to the top. With this in use the best method is to flood the carburetter, then remove the superfluous petrol from the dummy jet by means of a fountain pen filler or small syringe, until the float starts to feed and it is found impossible to reduce the level further. While this is being done it is advisable to tap the float chamber top gently to represent the vibration set up by the engine when running.

If the level of the petrol is found to be too low, a spot of solder should be run on to the float to increase its weight, or the jet may be shortened, provided that the latter does not alter the size of the hole. When the correct height of petrol has been obtained, the dummy jet should be removed and the working one substituted.

If any leakages have been discovered or the petrol level has been altered, make a test of the engine before proceeding further, noting possible improvement in the running. If none be noticeable, the next thing to do is to reduce the size of the choke tube, or if the choke tube be above the jet, as in fig. 2, to alter its arrangement to that shown in fig. 11, which is a simple method of reducing the size of choke tube, and also bringing the restricted portion well below the jet; it also has the advantage that the available area can easily be enlarged. Bear in mind that a slight reduction in the size of choke tube will make a great difference in the running of the engine. At the most the hole should not be reduced or opened out more than $\frac{1}{8}$in. between each trial.

FIG. 11.

As the reduction of the choke tube will have increased the supply of petrol, the jet orifice will require reducing in size to counteract this. The best plan is to solder up the hole and reopen it to a smaller size with a reamer made by grinding a flat on a sewing needle. An attempt to burr it up with a hammer generally results in an irregular hole or a split jet. The closing up of the hole in the jet does not necessarily mean that less petrol will be delivered, for as the choke tube has also been made smaller the pressure tending to force the petrol through the jet has been increased.

The auxiliary air supply should now receive attention. Before the reduction of the choke tube it was probably little used, but now, with the smaller choke tube, its use will become very necessary to obtain the best results and economical running. If it be hand controlled it will be rather troublesome, this can be obviated by fitting a spring-controlled air valve into the body of the carburetter, as shown in fig. 12, or in any position so that the air enters between the jet and the throttle.

Hot Air Supply.

From the point of view of economy, and also with a view to keeping the cylinders clean to guard against pre-ignition, it is of the utmost importance that either the carburetter itself or the air supply be thoroughly warmed in some way. The writer has come across several cases of pre-ignition caused by an accumulation of soot in the combustion space, which to all appearances was due to too rich a mixture. Yet, despite the fact that the auxiliary air was set so as to cause firing back into the carburetter with the slightest increase in opening, a cure was not effected until the mixture had been thoroughly heated up. With these old carburetters, if a hot air pipe was originally fitted, it was probably left off altogether by the first repairer who had occasion to take down the carburetter. Taking a small quantity of exhaust gas and passing it round an annular chamber on the body of the carburetter is of little use, for the pipes become choked in the first few hundred miles. A better plan is to lead some of the water from the cylinder jackets round the carburetter body, but unless this is supplied through large pipes the flow of water is rather weak, and is apt to freeze up solid with a severe frost, assisted by the refrigerative action of the carburetter itself, before the water is properly circulating. Probably the simplest and best way is to take a supply of heated air from a box surrounding the exhaust pipe. The pipe connecting this box to the carburetter should be as large as possible. If a carburetter be sufficiently heated the inlet pipe will be sensibly warm to the touch.

Improving an Old Type Longuemare.

In the foregoing notes it has not been the writer's intention to give any specific instructions for the adjustment of any particular carburetter, but rather to give sufficient information to enable anyone to reason out for himself his own particular carburetter troubles. Perhaps, however, the following example of an improvement effected in a well-known and widely used carburetter may be of sufficient general interest to warrant a description being given here.

CARBURETTERS. (131 *continued.*)

I refer to the model B Longuemare carburetter, which is fitted with a jet peculiar to itself. This undoubtedly possesses many advantages; one is the ease with which the jet area can be altered, and another is that the height of petrol can easily be ascertained. Now, while these carburetters give satisfaction as far as general running is concerned, very poor results are sometimes obtainable at low speeds. By reducing the choke tube area satisfactory slow-speed running can be obtained; but then it will be found that the auxiliary air supply is insufficient to keep the petrol consumption normal at high speeds.

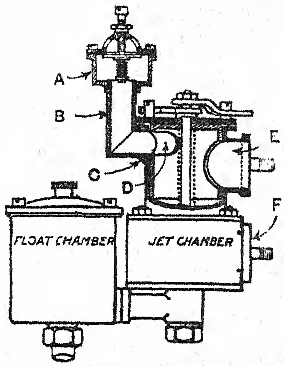


Fig. 12.

The following is a method the writer has adopted with this pattern of carburetter with satisfactory results: Into the side of the throttle chamber at C (fig. 12) a $\frac{7}{8}$in. hole has been drilled, into which has been fixed an elbow B, generally made from a piece of $\frac{7}{8}$in. cycle tube by mitring and brazing the joint. It is important to see that sufficient clearance is allowed for easy removal of the float chamber cover. This elbow has been well soldered into the throttle chamber at one end, and the other has been furnished with a spring-controlled air regulator. As the throttle is in the form of a tube, with only an opening for the gas, it was necessary to cut a slot in the throttle, as shown at D in fig. 12, to provide an opening for the air entering by way of the air regulator at any point in the travel of the throttle. The choke tube must also be reduced in size by inserting a strip of tinplate into it until the opening round the jet allows about $\frac{1}{32}$in. clearance. In some cases an eight-slot jet has been used, while in others two of the slots have been soldered up, leaving only six to supply the petrol. The variation can be accounted for by the fact that these slots differ slightly in size. The above alterations have always resulted in a remarkable improvement in the flexibility of the engine and increased power at slow speeds, while any reduction in the maximum speed of the car (if any) has been too small to be noticeable.

In conclusion, I would again impress upon the experimenter the necessity of first making sure of the results of one alteration before commencing another. Be certain that

ignition and valve troubles are not set down to the carburetter. It is advisable before commencing a carburetter adjustment to grind in all the valves, especially the inlet, and to make certain after the grinding that the clearance between the valve stems and tappets is sufficient. The slightest leak through an inlet valve will play havoc with the mixture at slow speeds, for every time the cylinder with the leaky valve fires a quantity of exhaust gas will leak into the inlet manifold and contaminate the mixture it contains. A curious point about this fault is that while the cylinder with the leaky valve may fire perfectly, it may cause one of the other cylinders to misfire at low speeds. A small leak is the more troublesome to locate, for a bad leak past an inlet valve will generally show itself by firing the mixture in the inlet pipe and carburetter.

This must not be confused with the firing back due to too weak a mixture, which is due to the mixture burning so slowly that the residue in the cylinder when the inlet again opens is still slight, and fires the mixture being taken in.

So important is this point of leaky inlet valves when tuning up a carburetter that it is advisable to remove the inlet manifold and test each valve separately with a smoking taper or piece of smouldering paper, which will show up the slightest leak by the deflection of the smoke when the engine is cranked round. This smoke test is the most convenient too for testing the joints of the inlet system for leaks.

In making adjustments to a carburetter there are bound to be a few backfires into the inlet pipe, and as this is liable to set alight any petrol that may have run into the shield or be overflowing about the carburetter, it is as well to carry out the alteration in the open or see there is ample ventilation and have ready at hand a bucket or two filled with sawdust. Not the slightest alarm need be felt if this sawdust is handy, as it is a most effective petrol flame extinguisher. On no account use sand, as it is impossible completely to remove this from the working parts of the engine, which it will ultimately ruin. The sawdust is quite as effective; for this the writer can vouch by quite a number of experiences, But with care in the way of preventing the excess of petrol from accumulating in the undershield no fear need be felt at the possibilities of fire arising from any attempts to improve the running of the engine by carburetter adjustments.—W. BOURNE DALE.

CLUTCHES. CHANGE-SPEED GEAR AND TRANSMISSION.

LEATHER CLUTCH RIVETS A SOURCE OF TROUBLE.—HOW TO CUT A CLUTCH LEATHER.—FIERCE LEATHER CLUTCHES.—A TEMPORARY REMEDY FOR FIERCE CLUTCHES.—SLIPPING CLUTCHES.—UNBALANCED CLUTCHES.—MULTI-DISC CLUTCHES.—A STICKING CLUTCH.—HOME-MADE CLUTCH STOP.—OVER-GEARING.—A CURE FOR LEAKY GEAR BOXES.—LEAKY BACK AXLES.

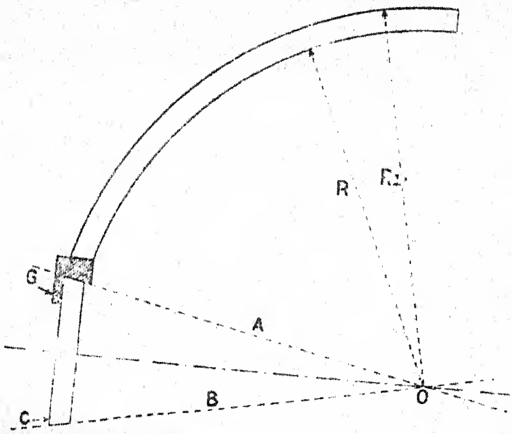
Leather Clutch Rivets a Source of Trouble.

132 The usual method employed to fix the leather to the metal centre of a clutch is to rivet it up by means of a number of copper rivets, whose heads are countersunk into the leather. If the rivet heads are not knocked in lower than the outer surface of the leather, then when the clutch is let in these grip fiercely on the metal outer clutch surface, and thus prevent the clutch working smoothly, and gradually getting up way on the car. Some difficulty may also be experienced in taking out the clutch, owing to the seizing of the copper rivet heads on to the metal clutch. As it is rather difficult to obtain leather suitable for clutch work of any greater uniform thickness than a quarter of an inch, and some of this must be turned off in truing up the leather after riveting, there does not remain more than an effective depth of one-eighth of an inch of leather held by the rivet head, and this should be one-sixteenth of an inch below the leather outer surface, to allow for wear and compression. Those who experience trouble with fierce clutches should examine the rivets, and knock them lower if level with the leather outer surface.

How to Cut a Clutch Leather.

133 If it is desired to obtain a new clutch without putting the car out of commission, a pattern for cutting the new leather can be made in the following simple manner: Let a template G be carefully cut out in cardboard, so that the angle of the clutch is faithfully represented, and then by its means a side elevation of the clutch G C can be set up full size on a smooth wall or a drawing-board of sufficient size. The sides of the cone A B should be produced until they bisect at O. Then from the centre O, with the radii R R_1, the two curves shown can be described, and if the

outer one is continued until it is three times the length of G C, the curved lines will show the form in which the leather strip must be cut in order that it should sit properly upon the male portion of the clutch. If the diagram is made on paper, the pattern can be cut directly therefrom, and the leather dressers will send the proper shaped piece straightaway. The clutch angle is best obtained by inserting a strip of tin between the cone faces and bending up the square with the edge of the flywheel.



Fierce Leather Clutches.

134 The first point which occurs to one in connection with a fierce leather-faced cone clutch is the condition of the leather, and the usual remedy is to dress it with castor oil laid on with a brush or feather and with the clutch pedal held down by a piece of wood, or otherwise, to give the oil a chance to soak in well.

If this method result in a cure which is not of lasting effect, the following plan may be tried : Take the clutch right down, detach the cone, or, if possible, draw it back so that the whole surface of the leather is clear of the flywheel and exposed in a convenient position. Now, with a stiff-bladed knife, scrape off the " skin " or polished surface of the leather, taking care, of course, not to cut the leather or scrape away more than just enough to expose the grain of the material.

When this " skin " has been removed, damp the leather all round with water applied by a small sponge. Do not make it dripping wet ; just moisten it slightly and let the water

soak in. Then apply a liberal coating of castor oil—do not be afraid of using too much—and, following this, lightly " stab " the whole surface with the point of a penknife, making incisions about a quarter of an inch apart, and letting the tip of the blade penetrate about one-eighth of an inch or so. This process does not, the writer's experience proves, spoil the leather by making it liable to tear or break away, as might perhaps be imagined, but it has the beneficial effect of allowing the castor oil, in a comparatively short space of time, to penetrate well below the surface, and so cause the leather to become thoroughly impregnated with the dressing.

Immediately the " stabbing " process has been carried out, apply another plentiful coating of the oil, and repeat the application some four or five times, allowing a period, of some hours perhaps, for each " dose " to soak in before giving the next. The leather will absorb the dressing better if the clutch is kept in a warm place meantime, and if the oil itself is warmed before being applied.

By the way, some manufacturers keep their stock of new leathers in the stores immersed in castor oil. So there need be no fear of overdoing this process of dressing.

Even yet, with all these applications of dressing, the leather is not *perfect*. The ideal condition for a clutch leather to be in is that it should be soft and yielding, but with a highly polished surface. One way of obtaining the latter essential is by more or less lengthy use; but the same effect can be secured at once by sprinkling a small quantity of powdered blacklead (which can be obtained from any oilman or grocer) on the surface of the leather, and then rubbing it in well with something smooth, such as the bone handle of a table knife.

If there should be any tendency for the clutch to slip when it is first used after being treated in the manner advised, tighten the spring until it is rather stiffer than usual, and keep it so for just two or three runs; after a very little use the normal adjustment can be resumed.

That is the sum total of a good method of curing a fierce clutch if the fault do really exist in the condition of the leather. But there are other matters which may cause this objectionable condition of things.

For instance, some part of the " motion " (the moving parts or rubbing surfaces which come into play when the clutch pedal is depressed or raised) may be binding—not working freely—by reason of being too tight in or against some corresponding detail or from want of lubrication. Such would prevent the clutch movement from following that of the

driver's foot, and the process of letting in the clutch would then become a series of small jerks.

These jerks in the movement may not be apparent when the pedal is depressed or raised, except when the engine is running and the car is in gear, for in actual use in transmitting power the first engagement of the two surfaces forming the clutch imparts a torque to the keyways, squares, or forked ends of the telescopic coupling which must exist between clutch and gear box in some form or other, and it is when this torque occurs that a series of small jerks are occasioned by sluggishness in the motion, due perhaps to want of lubrication.

By the way, this want of lubrication may also be the cause of a clutch *slipping*—exactly the reverse effect !—if the friction in the motion is excessive. The power exerted by the clutch spring is then used up in attempting to overcome the friction and jamming of the movements.

To return to the subject of the fierce clutch. Another possible cause is that the forked lever (or whatever form the actual mechanism takes) which actuates the clutch may not be pressing squarely against the bearing to which it is applied. The tips of the forked lever may have worn unevenly, and one or other of the arms may have become bent. It is an essential for a smooth action that the fork-ends should make contact with the bearing on both sides at the same time when the clutch is withdrawn, otherwise when the latter is released, and it makes contact with the cone of the flywheel, it is " on the skew." This being so, the motion binds and eventually the clutch as a whole takes up the drive with a jerk.

If the clutch is of the multiple spring type, where usually three springs are used, the bolts of the spring may be binding in their holes in the clutch by reason, perhaps, of the holes in the internal " anchoring plate " having been drilled incorrectly spaced as compared with the corresponding holes in the clutch. That is to say, the two sets of holes may not be in line. By withdrawing the spring bolts and examining them, the correctness or otherwise of this suggestion can be seen, for, if the holes are incorrectly drilled, the bolts will show signs of wear at a point where they pass through the clutch. If such a defect be present and the fault be not excessive, the holes may be filed slightly in the required direction, but if the spacing be seriously at fault—and a variation of more than a sixteenth of an inch must be considered as such—three entirely new holes should be drilled in the plate, marking off the latter from the holes in the clutch.

A Temporary Remedy for Fierce Clutches.

135 I fear a good many owners of plain leather cone clutches are apt to convince themselves that a certain amount of fierceness is inseparable from the type, and they consequently never trouble to oil their leather until it gets painfully fierce, and makes the front wheels lift. My own idea and experience is that the leather clutch is the sweetest clutch on the road if it be attended to. In the ordinary way before I stop the engine after a run, I press down the clutch pedal, and squirt a few drops of collan oil on the leather, the spinning flywheel distributing them nicely round the entire surface. Next day the clutch will be perfect. But little as I declutch, an average run of, say, 150 miles is quite enough to throw off any loose oil, and to burn up that quantum of lubricant which has soaked into the leather. So within that distance the clutch has again developed a bite that may be felt, but a further application of oil has immediate and beneficial results. —B.H.D.

Slipping Clutches.

136 A slipping clutch is also a source of annoyance to the driver. This trouble may be due to want of adjustment—that is, the spring may require tightening, so as to compress the spring to a greater extent and cause it to exert more pressure. If a clutch begins to slip, it should be attended to at once, for otherwise the leather may soon be scorched, causing it to lose its nature and become hard and brittle. Once the latter condition has been reached, there is little to do except fit a new leather; but if the scorching has only affected the surface of the leather, matters may sometimes be remedied by scraping off the hard skin and redressing the leather, as described in regard to a fierce clutch. If it be possible, the clutch spring should be tightened after this has been done, so as to prevent an immediate recurrence of the trouble.

When a clutch commences to slip, and no adjustment of the spring is possible, the slipping may often be stopped by sprinkling fuller's earth on the leather. The clutch pedal must be held out, and the fuller's earth inserted between the flywheel cone and the leather. The application of collan oil will also often serve to remedy slipping, for the latter is occasionally caused by the leather being too dry.

When a clutch commences to slip, and no means are at hand to remedy the trouble, the plan should be to refrain as much as possible from driving with a full throttle, for usually slipping does not occur unless the full power of the engine is

being transmitted. To reach home or a garage where matters may be set right, drive therefore on no more than half throttle, and change into a lower gear earlier than usual when climbing hills. In this way the leather may be saved from being scorched badly, and the price of a new one and fitting may be avoided.

Do not put powdered resin on a clutch leather to stop slipping. It is a plan which remedies matters only very temporarily, and is liable to spoil the leather.

Slipping the clutch on hills by pressing on the clutch pedal to avoid clamping gear is a practice to be avoided. The leather of the clutch will not stand this treatment for any length of time, unless the clutch actually runs in castor oil, as is the case with two or three makes of cars. Except in changing gear or in starting, the clutch should be either "in" or "out"; no half measures.

A temporary and quick remedy is one often used by drivers of heavy vehicles. They take up the footboards, depress the clutch lever, and wedge it so that the clutch leather is out of contact with its driving outer portion. It will be found that the leather is riveted to the surface at regular intervals. Between the rivets the leather can be raised slightly and advantage taken of this fact. To remedy the slip some match stalks are required, and these are inserted into the leather midway between the sets of rivets at the back of the clutch. If this be done evenly all round, it will be found that the clutch will take up its work and will not slip.

Unbalanced Clutches.

137 Another insidious cause of coarse running of good engines is in the clutch cone. We say good engines advisedly. If a man owns an engine by a good maker, he naturally assumes that it is well balanced, and his confidence is justified in the majority of cases. If, however, he find more vibration than should reasonably be expected at high or fairly high engine speeds, it is quite worth while to look to the balancing of the clutch cone. It may be noticed on examining the flywheel that it has one or more holes drilled in its rim and sometimes in its disc. These holes have been drilled to balance the wheel, so that any slight inequalities of density in the flywheel as a mass or irregularities due to imperfect casting may be removed, after it has been carefully tested and ascertained from which part of the wheel the unbalanced weight should be taken. On the other hand, the clutch cone—that is, the male portion of the clutch which carries the clutch leather—is not always attended to by otherwise careful makers.

They may balance their flywheels very carefully, and yet forget that the clutch cone also requires similar treatment. The disturbing effect of an unbalanced flywheel is, of course, likely to be much more serious than that of an unbalanced clutch, owing to its greater mass. At the same time trifling differences in the weights of the clutch cone arms or sections of the rim will and do upset the balance of modern high-speed engines, and unquestionably provide one of the obscure causes of the coarse running at the higher engine speeds which must be frequently employed with a small engined and therefore necessarily low-geared car. We do not suggest the desirability of immediately taking out the clutch to ascertain if it be properly balanced, but rather when overhauling the car at any time it should be regarded as an investigation worth making if the engine do not run quite so smoothly as it should, or as might be expected.

Multi-disc Clutches.

138 Sometimes multi-disc clutches will give trouble. As a rule, if they pass through their first thousand miles or so satisfactorily and are properly used, they last without trouble almost indefinitely. On the other hand, if they are wrongly adjusted in the first place, the chances are that they will start slipping. This slipping very soon rubs away the oil between the rings, and the result is a continual grunting and grating till the clutch locks and takes the drive up solidly. When the plates get to this stage there is only one remedy, and that is to replace them by new ones or to have them repolished. Quite the best way of polishing them that we know was communicated to us by a very experienced motorist who had suffered trouble in the way we have mentioned. He took out the forty odd driving and driven rings from the clutch and handed them to Messrs. Alfred Herbert, Ltd., of Coventry, who for various purposes use magnetic chucks on certain of their grinding tools. These magnetic chucks are admirably adapted for holding the thin rings of a multi-disc clutch, as each ring is simply laid against the chuck and the current turned on, whereupon it is held firmly to the chuck plate, and there is not the least fear of it being distorted in any way. It can then be ground dead smooth all over on one side, after which the process is repeated on the other, and each driving and driven ring is similarly treated. The clutch is then reassembled, and, provided the correct spring adjustment is given and proper clutch oil used, it should be good for many thousands of miles without any further attention, other

than an occasional running off of the old oil, washing out with paraffin, and refilling with clean clutch oil. Incidentally, we may mention that the best way to wash out a multi-disc clutch is, after the old oil has been drained out, to fill it with paraffin, and then to run the engine for a few moments, depressing and releasing the clutch pedal four or five times, so that the paraffin may work in between all the plates. Of course, the car should not be driven with paraffin in the clutch. The paraffin should then be drained out, and it is just as well to leave the clutch with the drain hole downward for some few minutes, so that any slight particles of loose metal may drain right out. The clutch should then be refilled with its proper dose of the correct oil.

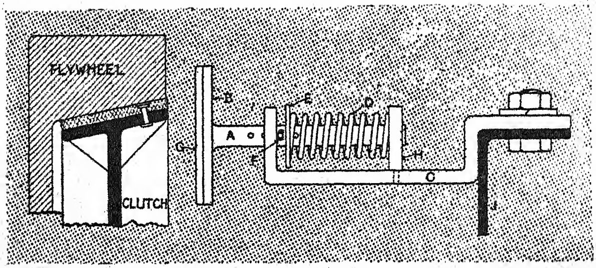
A Sticking Clutch.

139 An experience which I had recently demonstrates the necessity of occasionally draining out the old oil from multi-disc and expanding clutches and inserting fresh oil. I had returned from a forty miles run, and after the car had been washed and the tanks filled I attempted to diive it into the garage. But the only result obtained by depressing the clutch pedal and attempting to move the gear lever was a terrible grinding noise. Inspection showed that the clutch-shaft would not stop spinning when the pedal was depressed, and, notwithstanding the fact that the car had quite recently returned from a long run, it was subsequently found that this trouble was solely due to the thickness of the oil in the clutch (one of the metal expanding type). I may add that from all appearances the old oil had precipitated—if such be possible—and the part which was thick was preventing the clutch from working as it should. Of course, I washed out the clutch case with paraffin and petrol before inserting fresh oil.—L.D.S.

Home-made Clutch Stop.

140 The ordinary form of brake is rigid or almost so, and if the clutch pedal be moved half an inch too far the male member of the clutch is stopped dead—to the detriment of the gear wheels—instead of being merely slowed down so that the next higher gear will mesh noiselessly. The drawing shows a form in which the pressure applied to the clutch is practically constant from the time when contact is first made to the point when the clutch pedal is fully depressed. When driving—especially in traffic—one cannot pretend to control the movement of the clutch pedal exactly, which is really advisable with many clutch brakes, but quite unnecessary with the form in question.

It will be realised that when the male portion of the clutch is first withdrawn, it rubs against the leather pad G, and if withdrawn still further the spring D "gives" and a practically constant pressure is maintained against the clutch member. A square spindle or shaft A is brazed or screwed to the metal disc B; the frame C is merely a piece of iron shaped and bent up with a member H riveted or brazed to it. The spring, which may be an old exhaust valve spring, is held in place by a washer E and a stout split pin F. Several holes should be drilled in the shaft as shown, so that the position of the brake pad may be capable of adjustment. The disc must be covered with a leather G of similar thickness and description to that used for a clutch, and should be riveted in position with countersunk rivets.



The design will need to be varied and mounted to suit different cars in a manner depending on the design of the clutch and underframe; as shown, the brake is mounted on a cross member of the frame, but the shape can be varied to suit other positions, the side member of frame for instance. It is necessary so to adjust the brake that there should be some clearance between the clutch and the brake when the former is "in," so that there is not unnecessary contact when the car is coasting. In course of time a groove will wear in the leather, but if the squares be accurately cut the disc and its shaft can be turned about one square at a time, so that four different wearing surfaces can be presented in turn to the clutch member.

When starting the car from rest, it is, of course, necessary for the noiseless engagement of the first speed that the clutch and primary shaft attached thereto shall be stationary, and if the clutch pedal be fully depressed, this brake will arrest the motion of these parts in two or three seconds according to

the strength of the spring. The latter should be regulated by the weight of the primary shaft and the diameter and weight of the clutch member—the heavier these are the stronger the spring required—but for a given weight the larger the diameter of the clutch the lighter the spring required. A clutch brake of this type fitted to a car will afford increased facility for gear changing, especially when the primary shaft and clutch are heavy.—J. B. JOLLY.

Over-gearing.

141 There is something pathetic about the calm resignation with which most owners accept the ratio of gearing provided by the makers of their cars as the absolute ideal for their needs and locality. There is not a firm of any standing which does not offer a choice of gear ratios. Many owners omit to specify their special needs when they place an order, and certain firms are too short-sighted to write and ask for instructions. It follows that quite a number of cars are either over or under-geared for the districts in which they are running and for the loads they have to carry. This especially applies to chassis delivered in a naked condition for the body-maker in a distant town. Few people complain about under-gearing, although the owner of a medium-powered chassis who can start on top gear and do all his traffic work without a change down need not brag, for most men in his position would prefer a higher top gear ratio—not that I agree with them. Over-gearing is manifest in two respects :

(1.) If there is any hill which the car cannot negotiate on bottom speed when in good tune the car is over-geared.

(2.) If the car always labours and threshes a little when accepting its top gear on the level it is over-geared, and instead of trying to look as if he were totally unconscious of his pounding engine and threshing exhaust, the owner should apply to the makers for a smaller tail pin bevel. I believe this fault is rather common, and is due to the desire of many owners of small and medium-powered cars to obtain a higher maximum speed on the flat than is fair to the mechanism of the chassis.—B. H.

A Cure for Leaky Gear Boxes.

142 All gear boxes need a vent hole or valve quite as much as the crank chamber of an engine, for after a car has been running some little while the heat of the engine and that generated by the friction of the gear wheels and the foot brake raises the temperature of the lubricant within the gear box ; consequently the air within the box expands and

causes a slight pressure to be set up, which is all the while driving the oil out at the bearings. The pressure may be only a pound or two above atmospheric, but even that is sufficient to carry the oil with it as it gradually escapes between the shafts and bearings. A ⅛in. hole in the lid of the gear box will provide all the relief necessary.—B.

Leaky Back Axles.

143 Many back axles leak slightly round the joints of the central case, generally known as the differential case, which encloses the bevel, or worm as the case may be, and the differential. Some cases do not leak at all, but very few are quite free from a slight suspicion of oil exuding from one or more of the joints. While this leak remains only slight it does not matter, but if so much as a spot of oil drops from the axle when the car is standing after a run one should follow up the matter and be assured just where the oil is coming from and how much is really being lost, for unless this is done one may ruin a back axle for want of lubrication. As an instance of this we may cite an experience of our own. We noticed that after the car had come in from a good run a little oil had begun to drop into the tray on the floor of the garage. The leakage was not much, but it was a new vice. Now this particular back axle has an oil filler which enables the level to be tested, so that it is never possible to overfill it, unless one is grossly careless, and it usually runs for six weeks without requiring any replenishment. Upon examination immediately after noticing the leak referred to we found that, although it was only a fortnight since the case had been filled, the oil had fallen to "half-tide." We therefore refilled and took the precaution to examine the level again after a fortnight had elapsed, and found that the oil had again wasted much too fast. We filled up once more, and the car stood for a week without a drop leaking into the floor tin.

It appeared that the trouble was at an end, but the next time the car came in we made a very careful examination of the back axle—which, of course, was slightly warm, as is always the case after a continuous run—and found that the oil was oozing through the casing itself by way of a hole too small to detect with the naked eye, though not too small to prevent the warm oil from running out. Luckily the hole was in a convenient position, that is to say, it was on the detachable cover of the thrust bearing, so that we could easily detach the portion of the case where the leak occurred. After carefully cleaning and scraping it we found that a tiny blow

hole right through the casting had developed. We feared at first there might be a crack, but it being only a blow hole there was no necessity to fit a new cover, the trouble being cured by drilling a hole with the blow hole as a centre and putting in a screw and cutting it off flush with a hack saw.

The moral of all this is that happy-go-lucky methods must bring trouble. Had we not made certain of being on the safe side by testing the oil level of the back axle directly we detected the small leakage we should undoubtedly have ruined the worm, worm wheel, and bearings owing to want of lubrication, for the car would not have run a great number of miles before the whole of the oil would have leaked out.

BRAKES AND STEERING.

Testing Rear Wheel Brakes.—Noise Caused by Brake-work.—Attention to Brake Connections.—Rusted-up Brake Joints.—Curing Harsh and Squeaky Brakes.—Wear of Expanding Brakes.—Rear Brake Friction.—Graphite for Chattering Brakes.—Foot Brakes Shuddering.—Careful Drivers and Brake Adjustment.—Brake Efficiency.—Rubbing Brakes.—Stiff Steering Swivels.—Stiff Steering.—Encasing Steering Joints.—The Care of Steering Joints.—A Steering Gear Repair.—Steering GearFa ilures.—Steering with Broken Gear.—Broken Swivel Axle and Ball Race.—To Prevent the Steering Rod Falling.

Testing Rear Wheel Brakes.

144 It is a good plan to test the rear wheels now and then with a view to seeing that they revolve freely. It occasionally happens that a great deal of friction exists in the transmission gear or because the brakes bind. In the ordinary course of things, being quite unexpected, these points are generally overlooked until discovered casually. Sometimes the brake shoes, either on the propeller-shaft or in the drums on the rear wheels, do not clear when the brake is released. Occasionally, too, the release springs which are sometimes fitted are weak, or one of the connecting rods rubs against the frame, etc. Or it may be that the brake shoes are covered with congealed oil, in which case they cannot clear the drum easily. The friction which is set up from one or other of these various causes not only hinders the speed of the car, but sets up abnormal wear. It is no wonder, then, that the brake power is often found to be insufficient when most needed. In some cases the addition of a small pair of release springs on the rear brakes has proved very beneficial when the shoes are inclined to rub on the drum. But before trying this plan, the shoes should be examined in order to see that they work freely and are not impeded in any way. If required, the springs can be easily attached, and are very cheap, a few pence being generally enough to get a useful pair. It sometimes happens, however, that no mechanical cause for loss of brake power can be found, and so some other cause must be sought. Occasionally the fault arises from an

abnormal quantity of grease on the shoes. It is really surprising at times to see the quantity that collects between them and the drums, as one would have thought that the heat would be sufficient to melt it. The rear brakes seem particularly liable to this trouble, as a great deal of grease often escapes through the live axle and settles on the drums.

Noise Caused by Brakework.

145 There is a wonderful difference in the noise created by different makes of cars which cannot be accounted for by ordinary inspection when the car is standing. The engines may be equally noiseless, the exhaust ditto, and yet there is always noticeable with certain cars a large amount of rattle which is never found in others. A careful inspection whilst running, however, will enable the owner to find out that a lot of this noise is caused by the vibration of brake rods, unstayed pipes, brakes, brake bands or shoes, and the necessary connections thereto. To locate these noises, it is necessary that someone drives the car whilst the observer endeavours to find out whence the noise comes. Judicious staying of pipes, rods, or the fitting of small springs and plate brackets, so that the brakes, when taken off, cannot be always rattling, has, in the writer's experience, wonderfully altered the amount of noise in running a car, and turned what was a rackety contraption into a really sweet-running vehicle.

Attention to Brake Connections.

146 Although we never advocate disturbing the mechanism of a car unnecessarily, it is always wise when any defect is discovered to remedy it as soon as possible. Of course, the most vital points are the brakes and the steering. If any failure in the power of the first or the quick action of the second is noticed, it should be looked to at once. So far as the adjustment of the brakes is concerned, provision is always made for shortening the tension rod or rods, so that the brake pedal will not be as low down or as far forward as it is possible for it to be pressed before the brake is at full power. The brake pedal should always give at least an inch clearance when the brake is as hard on as it can possibly be applied. The same remarks apply to the side brakes, and in this case the hand lever should not be much more than half-way along the sector when the brake is nearly full on. The connections of the brakes should be examined at regular intervals, and if any sign of failure is noticed, it should be put right immediately. In all properly finished cars the nuts, with the exception of those which are provided for adjusting

purposes, are pinned, so that they cannot possibly come loose. The adjustment nuts are provided with lock-nuts, and care should be taken to see that they are properly tightened.

Rusted-up Brake Joints.

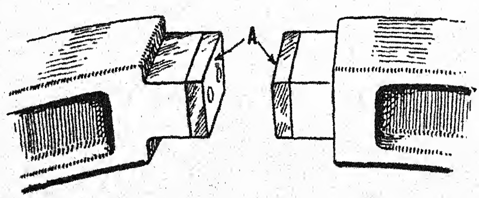
147 There are many cases of knuckle joints in brake connections, especially those hidden away in the body out of sight, becoming rusted. This rusting might easily be the cause of serious accidents, such as one brake acting and not the other, and swinging the car round. We strongly urge our readers to give careful attention to these joints from time to time. If the joints are well oiled with a thin lubricant and then well covered with grease, much can be done to prevent this trouble.

Curing Harsh and Squeaky Brakes.

148 So long as the surfaces of the drums and bands or shoes on brakes are clean and bright they will act well and smoothly, but directly either gets rusty the brake becomes harsh in its action and squeaks. The rusting of the brakes is due to unavoidable circumstances, as it is impracticable to dry the drums and brakes after the car has been washed, but the unpleasant feeling and harsh sounds of the brakes can easily be overcome by squirting a little paraffin over the drums before starting out for a drive. Paraffin, whilst being an oil, is not a good lubricant, but it is just sufficient to ease the action of the brakes without impairing their powers.

Wear of Expanding Brakes.

149 Users of expanding brakes should examine these mechanisms from time to time, particularly the pedal brake, as that gets such very hard work. After a car



has travelled any distance over 5,000 miles the drum, if originally rather thin, may have become so much worn that there is not sufficient material left to resist the bursting strain set up by the expansion of the shoes inside it.

I own a 20-32 h.p. Darracq, which is fitted with an expanding brake, and I found it had a tendency to wear rather quickly. The price charged for renewal is more than one would expect, and consequently I looked round for a way out of the difficulty. What I have done for two years is as shown on the accompanying drawing, viz., had "pegged" a small piece of steel A on each shoe, about $\frac{1}{8}$in. thickness, then when the shoes are further worn this is taken off and a piece $\frac{1}{4}$in. thick, and so on. The cost is very small indeed, and the job such a simple one that it can be done by any ordinary man with a small knowledge of engineering.—JOHN H. HALL.

Rear Brake Friction.

150 Amongst the occasional causes of lost power may be numbered a certain derangement of the rear brakes which is not readily identified, and which befell the writer some little time ago. Without any warning, his car evinced a sad falling away in power, first speed being required for quite insignificant gradients. Nothing amiss was discovered in a brief survey of the most likely details, and at last, by a stroke of luck, the car was one day pushed out into the yard for cleaning, instead of being driven out. The car proved to be immovable with the brake lever in the "off" position, but could easily be pushed with the brake three notches "on." This was the explanation of the lost power. Many rear brakes are operated by a shaped cam working in an oval space between the loose ends of two shoes. A rather inaccessible adjustment on the brake couplings had worked loose and lengthened the connections, so that the brakes were "on" with the lever at either extremity of its quadrant, and "off" with the lever in the centre of its quadrant.—B. H. D.

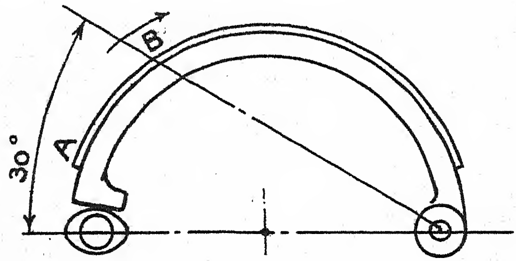
Graphite for Chattering Brakes.

151 Mention has been made in *The Autocar* of the difficulty of effectually dealing with and stopping the chattering of brakes of the metal to metal type, and especially that usually situated on the fore end of the propeller-shaft. From practical experience the writer has found that the use of oil or grease as a cure or preventive is not to be recommended, for the good effects obtained are not lasting. A far better substance to apply is graphite, which enters the pores of the metal surfaces, and owing to its being able to resist the heat necessarily set up by the brake action, the benefit derived from its use is more lasting.—C. R. GARRARD.

Foot Brakes Shuddering.

152 When the foot brake is on the propeller-shaft there is a considerable amount of spring between it and the road wheels, and many cars suffer, when nearly stopping, from more or less violent shuddering from the foot brake. There are several points to be looked into to improve, if not cure, this.

In the very first place, the brake liner friction must commence far enough back on the brake shoe so that the direction of rotation will not tend to pull it on by its own friction; thus, if the direction of rotation on the sketch is clockwise, and the brake liner friction begins right down at A,



it will tend to pull the brake on, and sometimes cause it to jump on and off very violently. It is much safer to begin at B, or something over 30° from a line drawn through the centre of the brake drum. If this, however, has been attended to, and the brake still shudders, the next easy step is to use some graphite lubricant instead of ordinary oil. Many brakes are made with the friction shoes plugged with graphite in holes 7 or 8 mm. diameter, and tapered from the inside to the outside so that the graphite plugs cannot fall out. Another remedy that has proved successful is to use a textile brake liner such as Ferodo or Raybestos. Sometimes it has been necessary to use the textile brake liner and the graphite as well.

Careful Drivers and Brake Adjustment.

153 It seems a strange thing to write, but the fact remains that the considerate driver is more apt to let his brakes get out of adjustment than one who drives badly and depends too much upon his brakes. A man who drives on the brakes is bound to have them fairly well adjusted or he gets into trouble at once. On the other hand, a

good driver who never has to apply his brakes suddenly, except through the carelessness of some other road user, is less apt to observe that his brakes have lost power. It is quite possible to have brakes which will hold the car in check down any hill provided a slow start is made, as it always is by a careful driver. On the other hand, should it be necessary to make a very sudden stop, the brakes may have lost what we may call the intensity of their grip. That is to say, when they are almost fully on they will lack full power. We call special attention to this matter, because quite recently one of the most careful drivers we know narrowly averted a collision owing to his brakes requiring a little taking up. As he always drove carefully the brakes had gradually lost power without causing him the smallest inconvenience, but one day a cart unexpectedly drew over to its wrong side, and on suddenly applying his pedal brake he found, to his horror, it was not gripping sufficiently hard to stop his car suddenly. He instantly put on the side brake as well, and just managed to pull up, but the affair was a matter of inches, and the escape from a serious accident far too near. Now, if he had been in the habit of using his brakes violently, and depending upon them unduly, as so many drivers do, he would have discovered the need for adjustment long before. There is no need to dwell upon the matter, as the moral is obvious, and we would only add that sudden stops should never be made unless they are the less of two evils, as it is better to strain the car and damage the tyres than to collide with anything, but it is therefore necessary that the brakes should always be so adjusted that if needs be a sudden stop can be made.

Brake Efficiency.

154 Probably every motorist is aware that the efficiency of a brake falls rapidly immediately the wheel is locked and caused to slide. Up to the point of locking, the braking power naturally increases, and to get the maximum effect from the brake system it is obviously desirable that each brake should be capable of application up to, but just short of, skidding of the wheel.

In order that both these brakes should give these results it is naturally essential that the compensation should be perfect. The word "compensation" applies not only to the pull given to the brake mechanism, but also to the condition of the braking surfaces. If oil get on to one brake surface it is obvious that that brake is not likely to skid the wheel, and it will be found, if great pressure be applied with the

lever or pedal, the other wheel will be easily locked without the brakes as a whole being effective. A careless driver will not take the trouble to notice that it is only one wheel that skids, and will imagine that he has reached the limit of effectiveness of his braking system.

To correct this it is necessary (and the same should be done from time to time as a matter of precaution) to test the brakes on some steep hill and notice whether one wheel is more prone to lock and skid than the other. If this be the case the brake surface on the wheel which does not skid should be examined and cleaned, or if the brake system be not compensated, the brake in question should be adjusted so that when skidding occurs both wheels skid at the same moment.—E. W.

Rubbing Brakes.

155 A lot of power is wasted and considerable needless wear incurred by the fact that so many cars have their brakes badly adjusted, so that they are rubbing constantly when they should be entirely out of action. This is not always due to bad adjustment, as there are some brakes which are so badly designed that it is impossible to keep them free of their drums when out of action unless certain structural alterations are made. There is one matter, however, in connection with brake adjustments which requires special attention with new cars, and that is the peculiar habit some cars have of tightening their own brakes. When one has a new car, and is satisfied that the brakes are not rubbing when out of action, one should feel absolved from any further trouble till such time as the brakes show signs of losing power, and, therefore, of requiring adjustment. It is none the less necessary to feel the brakes periodically to see that they have not heated after a drive. We have had new cars which run without heating their brakes at all for two or three hundred miles, sometimes more, and then one or other of the brakes would begin to rub and get hot, the only remedy being to slack the adjustment off slightly. We do not profess to account for this "self-tightening," except to say that the convenient method of adjustment provided on many cars to-day is apt to lead to trouble. The automatic nut-locking devices which are held up to their work by a spring may cause trouble, as the intermediate positions of the adjustment make the brake tighter than when the tongue piece is in the actual locked position, and this has no doubt given rise to a good deal of needless brake wear—in some cases to more serious

damage still, as the drums have occasionally become so hot that the heat has been communicated to the bearings; this has been the case particularly in the counter-shaft and propeller-shaft bearings.

Stiff Steering Swivels.

156 Some little time since we found the steering of a car we were driving become so stiff that it was necessary to be continually setting the wheels to keep the vehicle progressing in the required direction. The work necessary on the steering wheel was such that the shoulder muscles were quite stiff after driving fifty miles or so. Upon both wheels being jacked up clear of the ground and the steering wheel manipulated, it was obvious that the stiffness was due to something in the steering gear itself, and not to the extra large tyres with which the road wheels were shod. The steering gear was subsequently taken down, and it was found that, although the greasers had been filled and screwed home again and again, the swivel pin on the offside had never received any of the lubricant and had become quite rusty. The fault was not with the makers of the car, but with the grease which had been used in the grease cups, this being much too stiff for the purpose. The makers of the car say that, in the case of the lubricant intended to be used for these cups, they find it necessary to thin down the ordinary grease supplied by mixing with it half its volume of oil. If any of our readers' cars are suffering from stiff steerings a clue to the trouble may be obtained from the experience given above.

Stiff Steering.

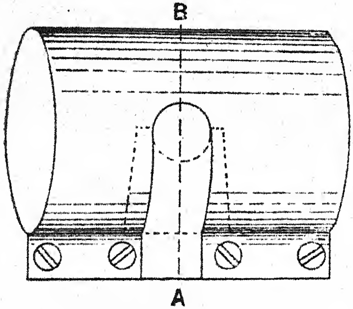
157 Sometimes the steering will become stiff, despite the fact of it being apparently well lubricated. This is particularly the case with cars which have no ball bearings to the steering pivots, though these too will sometimes become unaccountably stiff, despite the fact that all the greasers are filled, grease passages clear, and everything properly looked after. In all probability if the car be jacked up the steering will be found perfectly free. Of course, if it be not it must be disconnected and the stiffness traced to the steering box, the steering pivots, or the coupling rod bearings. In nine cases out of ten, however, the mere jacking up of the car and relieving the steering pivots of weight will do all that is required so long as the grease lubricators are all screwed down fairly hard before taking the car off the jacks. The stiffness is simply caused by the weight forcing out all the

lubricant from between each steering pin and the socket and also around the ring of the socket. This, of course, is rectified at once when the front axle is jacked up, as the grease can then penetrate between the socket and the pivot pin. While the car is jacked up it is always a good plan to grease the bearings of the coupling rod thoroughly, and also to squeeze plenty of thin grease into the steering box and to work the steering wheel round several times, so that the grease is thoroughly spread over the working parts inside the steering box. This is particularly necessary when the steering is of the nut and worm type, as this type is more apt to get dry than the more usually employed worm and segment. This intermittent stiffness of steering, due to the squeezing out of the lubricant by the weight of the car, is a most troublesome complaint, though the remedy is simple. Indeed, there are some cars on the road to-day which require jacking up for the screwing down of the lubricators every hundred miles if the steering is to be kept thoroughly free and smooth in action. Of course, stiff steering may be, and often is, due to bad design of workmanship, and our remedy is intended for steerings which, after being free, gradually become stiff for no apparent cause.

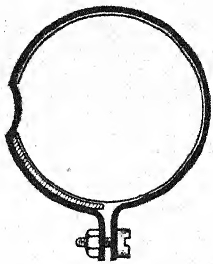
Encasing Steering Joints.

158 On a number of cars the steering mechanism, which is really a most vital portion of a car, receives the least attention. This is not as it should be, as there is always a small amount of movement taking place on all the working parts during the time which the car is in motion. Since on the forward ends of the steering levers, at any rate, plain pins are mostly used, any wear on these parts cannot be remedied, the only way of eliminating play at these points being the fitting of new pins. The wear on these particular pins is more excessive, as a rule, than it should be, simply because they pick up dirt and dust, and whatever small amount of oil is on them acts, with the dust, like emery powder to grind away the pins, and causes them to become loose in their holes. If the pins, in the first place, are properly lubricated, and then the whole joint encased in leather fittings, which can be bought from most accessory firms, and these cases are filled with vaseline or ordinary gear grease before finally binding up, they will be found to last very much longer and give much more satisfaction than is usually the case. The same style of leather fittings should be placed over the ball steering joints, and with such precautions very little atten-

tion is required at this most vital part. Whilst this method is satisfactory in use, it can hardly be said to be neat in appearance, nor add to the accessibility of the joint, particularly as the neatest coverings are sewn on. A good way of covering the joints is to have a clip made of brass or sheet steel in the form shown in the appended sketch. This is a plain



Cover for steering joints.



Section on the line A.B.

circular clip, having a slot cut in just big enough to take the diameter of the steering lever immediately above the ball. A strip of metal having a corresponding half-circle cut in one edge to fit up to the steering lever prevents the ingress of dirt through the slot which is cut in the clip. This joint makes a neat and accessible covering to a steering joint.

The Care of Steering Joints.

159 The four joints of the steering are apt to be very much neglected. By the four we mean the two ball joints of the steering rod and the two plain joints of the cross coupling rod. Although leather cases are so easily made and so cheaply procurable, many cars are going about with these four joints exposed to mud and dust. There is no better grinding material than road grit and oil or grease, and consequently these four unfortunate joints, which are amongst the most important on a car, are being rapidly worn away. On the other hand, some users seem to think that if they put leather covers over the joints they can practically neglect them for twelve months so long as they have packed them full of grease before putting on the leather covers. This is a mistake unless outside means of lubrication are provided, and even then it is advisable to remove the covers and to examine the joints occasionally. Some steering joints have little grease cups or small oil lubricators, which project through the leather casing,

so that lubricant can be added from time to time ; but many good cars are turned out without anything of the sort. The joint is simply smothered in grease, and then the leather case is strapped on. This does very well for a time, but at least four times a year the covers should be removed, the joints thoroughly cleaned with paraffin, and then they should be carefully and copiously oiled before being repacked with grease. While doing this they should be most carefully examined to see that all nuts and pins are absolutely safe and sound, and that no undue wear has taken place. Of course, the ball joints can be adjusted, but the two plain joints of the coupling rod are non-adjustable, and if much worn it is necessary to fit new pins or to rebush the coupling rod.

A Steering Gear Repair.

160 When the teeth of a detachable sector in a steering gear are worn the defect may be cured without fitting a new one.

First remove the sector and spindle, and try the two halves of the box together on the steering column. If slack, smear a film of vermilion and oil on a surface plate, or, failing that, a thick piece of plate glass. Rub the butts of the box on it, file where marked, and continue until there is no shake when bolted in place on the column. Slackness in the sector spindle bearings is irremediable, as the metal is too thin for boring and bushing.

Next detach the sector, and if it be of hardened steel, heat to redness and bury in unslaked lime until cold, in order to soften it. Should there be any play between the ends of the worm and box, cut a thin washer to suit and fit it on, and the same to remedy lateral movement of the sector spindle if in evidence. There is usually an adjusting screw to bear against the end of the column, but the washer will help.

Then solder a strip of thin brass foil, such as is used for cartridge cases, to the sector where it fits against the boss on the spindle, or if it be a steel sector, wrap the strip round the spindle, in either case using as little solder as possible (a tinsmith will make a good job of this). Then bed it carefully with a file against the spindle. The bolt holes will now be slightly out of register by the thickness of the strip, so substitute temporary service bolts of smaller diameter. Bandage the steering wheel to protect it, stand the column wheel downwards on two battens on the floor, and smear the worm lightly with the vermilion colouring. Pass one end of the sector spindle through that half of the box to which it

belongs, and coax the middle of the sector, where it is most worn, into gear with the worm. Back the box away from the sector, gear the latter, and try to force the bearings on to the column. If impossible, then, and only then, take a little more off the packing strip until the bearings will slip into place with the middle of the sector hard against the worm.

Then take a $\frac{3}{8}$in. round or square file, soften in the fire and grind or file the teeth from the end. Flatten out the end to about $\frac{1}{2}$in. broad and $\frac{1}{16}$in. thick. File up the sides, and then the end to a slight curve, leaving two sharp square edges like the sole of a skate blade. When stood vertically on a flat surface it should touch only in the middle. Finish with a smooth file, heat to redness, slake in water, and set sharp on an oilstone. A flat scraper will then be in your possession.

Now, keeping the bearings hard against the column, and with one foot on the steering wheel, force the box round in each direction as far as possible to mark the teeth of the sector. Disengage and scrape the outer marks, but do not touch those in the middle. Should the crests of the worm ride, grind the end of a square file to make another scraper to suit. Continue "offering," marking, and scraping until the worm beds firmly and well. Then remove the service bolts one at a time, and, if necessary, file the holes until the permanent bolts will drive in ; then bolt up for good and secure the nuts. Continue the scraping and trials until the sector butts against the box at each end of the stroke—usually about a turn and a quarter.

Bolt altogether, and, gripping the bracket in the vice, try the gear. It should be a little tight in the middle of the stroke, where most wear occurs, and easier towards the ends. Eccentric adjustments are not of much account, as the teeth must still be hand-fitted to compensate for unequal wear.

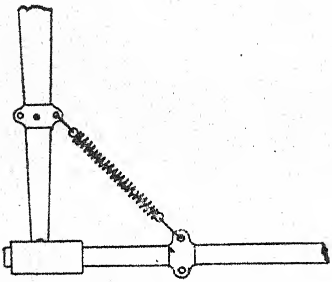
To harden a steel sector, heat to redness and fill up between the teeth with prussiate of potash, and let it burn in ; repeat heat again, and then slake in water.

It need hardly be said that those who have no mechanical aptitude should not attempt a repair of the above nature without skilled assistance.

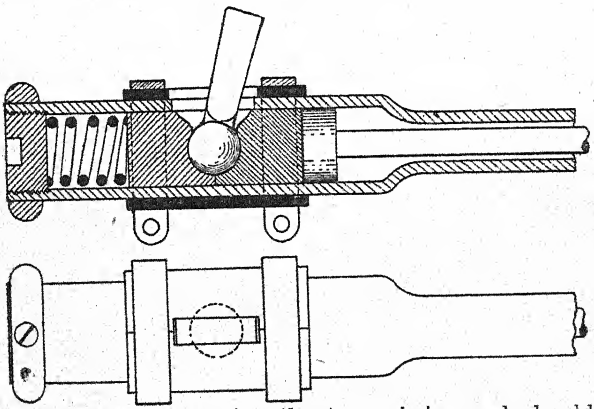
Steering Gear Failures.

161 A correspondent, Mr. G. Mead Robins, M.I.M.E., wrote in the spring of 1908 : "I have just had an alarming experience with the failure of the steering gear of my car, a 20-30 h.p. Renault. The trouble arose from the

fact that the rod which transmits the movement from the steering column to the steering rod relies entirely for its support on the two half-cup bearings remaining in good condition.



This transmission rod simply hangs in the bearing, and in my case the bearings became worn to the extent of allowing it to drop down, which disconnected the transmission from the steering to front wheels entirely. The feeling of absolutely losing the control of the car can be better imagined than described. Fortunately at the time I was going comparatively slowly, but fast enough to have an ugly experience on having to stop with force against the kerb. My advice is that till this defect in constructional detail is altered, to prevent the



possibility of this happening the transmission rod should be prevented from failing by the introduction of a suspensory spring (see sketch) and the half-cup bearings be looked to periodically. I think that, as so many types of cars have the particular system of transmission which has proved so disastrous in my case, the better plan to obviate accident will be to adopt what I have done now in addition to the suspensory spring, viz., making two half-sleeves in thin sheet steel that accurately fit round the steering rod, secured by

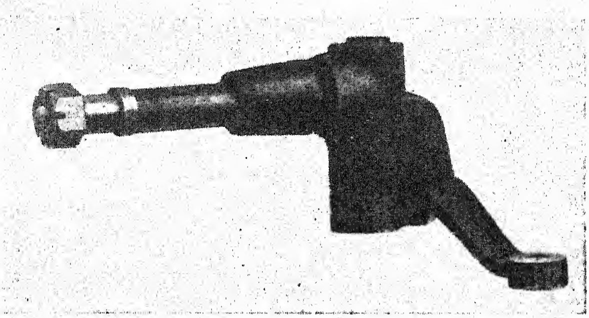
two clips round the steering rod, the upper portion of the clips being cut out to the width of the ball-ended steering lever itself. The lever slot is only of sufficient width and length to allow the ball-ended lever itself to travel through the maximum lock each way, and if the blocks in the steering arm wear through, it is impossible for the arm to drop. I am using this in conjunction with the suspensory spring.""

Steering with Broken Gear.

162 Happily steering gears are not now so prone to give way as they were a few years ago, but should any of our readers be so unfortunate as to have a distance rod of the steering gear come adrift, the following tip may be of use: Failing any temporary repairs, the car should be turned round by manual aid, and the front wheel which is not connected to the steering wheel should be lashed up to prevent its turning athwart the car. The vehicle may now be driven slowly backward, steering by the one wheel, which now becomes a trailer. This method is, of course, bad for the tyre, and should only be resorted to when a repair can be effected within a couple of miles or so.

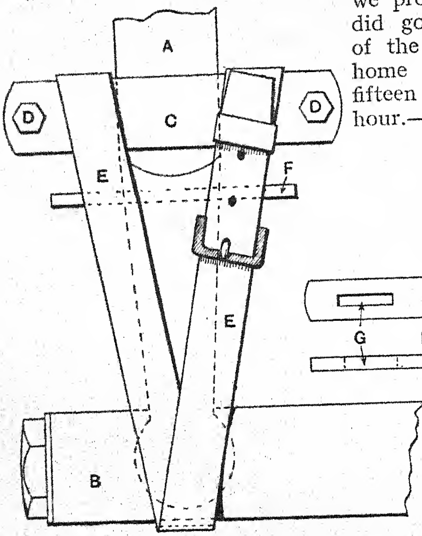
Broken Swivel Axle and Ball Race.

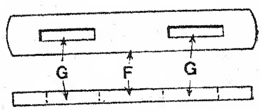
163 Whilst running over a comparatively rough road on a 15 h.p. car of good repute the front wheel came off without warning. The car dipped on the road at the



corner and came to a standstill without doing further damage. Examination showed that the inside ball race was broken, and also the swivel axle at the reduction beyond the ball race seat, just ¾in. from the neck. Whether the road was entirely to blame, or whether a previous flaw existed in the

swivel axle, is not certain. A passing motorist kindly took me to a country blacksmith's shop about two miles away. I thought to have it welded, but the smith reckoned that this could not be done. I got the blacksmith to make a collar (see photograph on the preceding page), and we joined the broken pieces by shrinking on the collar at a good heat. The wheel was replaced without the ball bearings, and getting under way carefully, we gathered confidence as we proceeded, and did good stretches of the seven miles home at about fifteen miles per hour.—R. M. L.





Device to prevent the steering connecting rod falling.

A, steering arm.
B, steering connecting rod.
C, metal plates with rounded top edges.
D, ¼in. bolts.
E, leather strap.
F, leather plate.
G, slots in F through which strap E is passed to prevent it slipping over the end of C.

To Prevent the Steering Rod Falling.

164 A simple means of preventing the steering rod connecting the steering arm and the steering lever on the front wheel from falling is shown in the above diagram. Two metal plates C are bolted by means of ¼in. bolts D on either side of the steering arm A. A leather strap E is then passed round and under the ball socket of the steering connecting rod B. A strip of leather F, in which are cut two slots G, is threaded on the strap E to prevent it coming adrift over the ends of the plates C.

TYRES AND WHEELS.

Tyre Valves in Wire Wheels.—Leaky Tyre Valves.—Makeshift Valve Cap.—To Stop Leaky Tyre Valve Caps.—Another Method.—"Airing" Spare Tyres.—A Makeshift Air Tube Protector.—Square Treaded Steering Wheel Tyres.—Tyre Pumps.—Temporary Repair to Steel-studded Cover.—Dummy Valves for Tyre Fitting.—Surface Cuts in Tyre Covers.—A Use for Old Covers.—How to Minimise Tyre Troubles.—Fitting Larger Tyres.—In Case of Puncture.—To Remove Solutioned Patches from Inner Tubes.—Flare Patches.—A Good Tyre Tip.—Inner Tube Accidents.—Security Bolts.—Bent Security Bolts.—Creased Security Bolt Heads.—Worn Security Bolt Heads.—Security Bolts close to Valve.—Cleaning out Tyre Covers.—Burst Covers.—Fitting a Gaiter.—The Spare Cover.—Tyre Brushes.—Mysterious Tyre Leakages.—Repairs at Night.—To Remove Michelin Detachable Rim Clamps.—False Alarm of Puncture.—An Ancient Tyre Tip.—The Care of the Tyre.—The Care of Tyres in Winter.—The Care of Rims.—Rust in the Rim.—Water admitted through Loose Spokes.—The Value of French Chalk.—Clearing away French Chalk.—The Preservation of Rubber.—Destructive Effect of Grease.—Use the Brakes Carefully.—Periodical Examination of Tyres.—Rubbing Tyres.—Inflation Pressures.—Mounting Studded Tyres.—The Blue Pencil.—Tyre Pump Washers.—Wooden Wheels out of Truth.—Testing Road Wheels for Alignment to Save Tyre Wear.—Shrinkage of Road Wheels.—On Inner Tubes.—Carrying Spare Tubes.—The Economy of Two Spare Wheels.—A Detachable Wheel Tip.—Rusting-on of Detachable Wheels.—Danger of Jack Slipping when Changing Wheels.—Dummy Hub for Garage Use.—A Stepney Wheel Tip.—Fitting Stepneys Single-handed.—Loose Wheels.—Removing Fixed Wheels.—Using a Home-made Wheel Extractor.

Tyre Valves in Wire Wheels.

165 All makers of inner tubes seem to fit valves with stems of uniform length, these being suitable for artillery wheels with thick wooden felloes, consequently when

such a valve is used in a wire wheel a very considerable portion of the threaded stem is exposed to mud and dirt, by reason of the valve cap not being of sufficient length to cover the stem. This results in the threads becoming rusty, and when the tube is being removed considerable difficulty is experienced to unscrew the rim nut. To obviate this difficulty I have fitted all my valves with extra protection. I have taken four spare valve caps and sawn off the closed ends, and have screwed the threaded tube thus formed upon the stem of the valve so that it butts against the rim nut. The ordinary dust cover can then be fitted as usual, and with the tubular piece it forms a complete protection for the whole length of the thread.—A.G.

Leaky Tyre Valves.

166 Having a leaky tyre valve, which on examination showed no defect either in the rubber with which the joint is made or with the metallic seatings, numerous attempts at tight screwing-up and the application of soft-soap failed to effect a remedy, but when a little ordinary sugar dissolved in water was rubbed into the valve rubber, the trouble immediately disappeared, and the stoppage of the leak was permanently effected. This is useful to know, as apparently the rubber is not caused to stick in any way, nor is any injury done to it.

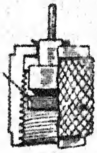
Makeshift Valve Cap.

167 If the valve cap of a tyre is lost at any time, a piece of rubber, leather, or rag should be put over the orifice and secured with an elastic band or piece of string round the stem, as if any dust gets into the valve it is almost certain to leak. It is always a good plan to make one or two strokes of the pump before screwing it to the valve, so that any dust or dirt which has lodged in the tube or nozzle is blown out and not forced into the valve.

To Stop Leaky Tyre Valve Caps.

168 Ninety per cent. of tyre valve derangements are unquestionably due to the rubber washer in the screw cap of the valve itself. We do not mean the large thimble which envelops the whole valve, but the little cap which must be screwed off before the pump can be applied to the valve. What occurs is this. When the valve cap is screwed home the rubber plug squeezes out of shape, and is more or less cut by the sharp edges of the valve, so that very small pieces or rubber are ground off it. These get into the valve, and before very long it commences to leak, when the only remedy is to let all the air out of the tyre, take out the valve stem, remove the particles of

rubber which have got into the valve, replace, and re-inflate—a laborious operation which no one willingly undertakes. To get rid of all this trouble it is only necessary to cut small hard leather discs which will just fit into the valve cap. The leather will not be cut by the screwing up of the valve cap, nor will it push into the valve as the rubber plug does. It is not necessary or desirable to remove the rubber plug in the valve cap, but merely to put the leather one on the top of it. The rubber gives a certain spring behind the leather, and is therefore beneficial.—F.J.H.



Another Method.

169 There is no doubt that at one time or another all have suffered from that troublesome little bit of rubber in the tyre valve cap, which sticks and tears, and often gets under the plunger, showing clearly that rubber is not a satisfactory material to employ for the purpose. Some time ago I tried a wad of soft solder in the cap in place of the rubber. This solder is sufficiently soft to bed itself up against the end of the valve, and makes a perfectly air-tight joint. It comes away easily when the cap is unscrewed. There is nothing more annoying than to have to deflate a tyre to put the valve in order.— J. A. MILNE.

"Airing" Spare Tyres.

170 It is advisable to inspect and "air" the spare covers and tyres which may be carried upon the car enclosed in waterproof covers, for, from experience, I have found that if such tyres remain in their coverings for some months they may become mouldy and rotten—probably owing to want of air to dispel the certain amount of dampness which must find its way inside the cover in course of time.—VENTILATION.

A Makeshift Air Tube Protector.

171 Being a medical man and not carrying a Stepney wheel, I had a tyre burst seven miles from home and only a spare tube with me. Knowing it was useless to put this in the cover with a 2½in. burst I was rather nonplussed, but, noticing a duster in the back box of my car, it dawned on me to fold this up and put it between the burst and the tube. This I did, and proceeded home without any trouble; in fact, I have run fifty-five miles since, and intend going on till the temporary repair gives way. I think it might be of use to motorists to know of this temporary tube shield in case they may be landed in the same predicament as myself.—W.R.W.

Square-treaded Steering Wheel Tyres.

172 We have had some complaints of late concerning the steering of a certain make of car which is justly famed for the excellence of its steering. We confess these adverse reports puzzled us, as we knew that each car of the make in question that we had owned or driven had steered exceptionally well. This interested us so much that we arranged with an owner, who told us he had bought his car on the strength of our high commendation of the steering, to bring it to us, so that we could carefully examine it and try it for ourselves. He did this, and every examination showed that the steering as such was in good order; but the fact remained that the car was very heavy to steer—not really bad, but heavy enough to be very tiring on a long drive. We were almost driven to the conclusion that the working joints of the steering must be binding when loaded, when we noticed that the front tyres were of the square-treaded variety, and as the wheels were somewhat canted we suggested the substitution of round tyres for the flat-treaded ones. The change instantly cured the trouble. It does not matter if the tyres be cross-grooved, but circumferential grooving seems to have some bad effect, though nothing like so bad as that of the square-treaded cover. Round studded tyres, too, have little or no ill effect. We do not say that all cars steer heavily with square-treaded tyres, but all we have tried do so, if the wheels are much canted.

Tyre Pumps.

173 Recently our tyre valves have been leaking, not one of them, but all five, as the tyre on the spare wheel has suffered with the others. When one valve leaks occasionally nothing much is thought of it, but to have all the valves leaking pointed to a common cause. It therefore occurred to us that the best thing to do was to overhaul the big three-barrel pump we keep in the motor house. The pump itself was all right, but we found that the rubber connecting tube was in a deplorable state internally, though perfectly sound and airtight. What appeared to have happened was that the pump had been at some time over-oiled and the oil from the plungers had been forced into the rubber tube. It had gradually rotted, so that the interior of the tube was in a semi-liquid state, and every time the pump was used it was evident a small quantity of gummy dissolved rubber had been blown into the valves, and being too thick to act as a seal had simply prevented the valves from seating properly. It is the first time we have come across this little difficulty, and the solution of

it may be useful to our readers, as there is no doubt that when a pump has been in use for some time there is every probability of the rubber connection rotting internally in the way ours did.

Temporary Repair to Steel-studded Cover.

174 Owing to some of the steel studs coming out of a Dunlop 810 × 100 mm. cover on one of the rear wheels of my car, the inner tube burst right through the inner canvas, leaving a hole in it the size of a pea. I took the cover off and fixed inside it over the hole a "dome of silence," then put another tube in, and blew it up. Like "Charley's Aunt," the tyre is still running. The idea occurred to me a month before I had occasion to put it into practical use, and I had carried six pennyworth of the domes in one of the car pockets for a month. After fixing the dome I ran the car for over forty miles and then took the cover off in order to fix a Presto liner, as nearly all the studs were ripped out, and I was afraid of another burst. The dome was firmly fixed inside the cover, and its round polished edge makes it impossible to cut the canvas. The tyre has since run 200 miles.—T.E.M.

Dummy Valves for Tyre Fitting.

175 A well-known tyre firm announce a wooden dummy valve to be used in fitting new covers to wheels, in order to register the tyre valve hole and the rim valve hole accurately. In many garages the tyre hand regularly employs the hammer end of a punch for the same purpose, and as soon as that part of the cover which is near the valve is bedded in the rim, he lets the wheel down on to the floor by screwing down the jack, so that this portion of the cover is kept *in situ* while he levers away at the rest. These two tips are as old as the hills so far as professional mechanics are concerned, but may not be known to many of our readers. Where security bolts are employed, and especially in fitting a new cover to a detachable wheel when not mounted on an axle, the fitting is often simplified by inserting an arc of the cover round a security bolt hole first, and temporarily screwing up that bolt in order both to clip and to register the cover. A security bolt should not be used in lieu of a dummy valve, *i.e.*, in the valve hole instead of in a bolt hole, because its stem is too thin to register the valve hole with complete accuracy.

A correspondent suggests an alternative method: I have been in the habit of using the valve cap for this purpose, the smooth end of which fits into the rim valve hole nicely. Unfortunately, the sizes of them vary somewhat, so that all do

not fit. I am lucky in that three out of my set of four fit the rim valve holes with a tight fit. As each car must have at least four of these which are always on the car, they come in very handy when the dummy valve cannot be found.—REGINALD HYDE.

Surface Cuts in Tyre Covers.

176 At any season of the year the necessity for filling up surface cuts in tyre covers is, of course, existent, but during the autumn and winter this necessity is increased, for with the tyres running constantly on wet roads and through sloppy mud the moisture is more likely to penetrate to the fabric, causing the latter eventually to rot, which state will in due time be followed by a burst. Now that portable vulcanisers are so cheap, it will always pay to vulcanise any cut at once so that no outside influence will be at work tending to disintegrate the tyre quicker than would be the case naturally. Before vulcanising surface cuts it is always advisable to dry the cover well before applying the plastic solution, and this may be done by securing the vulcaniser to the inflated tyre for some five or ten minutes with a moderate heat or steam pressure. This will dry the fabric in proximity to the surface cut, and will prevent the formation of steam when the hole is subsequently vulcanised.

An important item in the filling up of surface cuts is the roughing of the walls and edges of the actual cavity. It is not always sufficient merely to scratch the rubber with a piece of glass-paper or to wash out the hole with petrol; one of the specially made curved rasps supplied for the purpose should be used and the rubber roughened well with this tool. This method enables a far better amalgamation of the tread and the rubber filling to take place, and ensures that the filling will not subsequently be pulled out in use or the gaping hole to enlarge with the drag of the drive.

We have found that the small vulcanisers which are made nowadays for garage use and for carrying upon a car very quickly pay for themselves in the additional life given to the covers, which can receive periodical attention by surface cuts being filled and vulcanised. Of course, the vulcanising of the fabric by inserting a stepped patch upon a burst and subsequently vulcanising are matters which require a certain amount of experience and aptitude, but the filling in of surface cuts by vulcanising the plastic rubber is an even more simple job than vulcanising repaired punctures in inner tubes.

A Use for Old Covers.

177 The cost of tyres being a serious item in the expense of running a car, I have carefully considered how that expense can be reduced, and have hit on the following plan for using up my old covers. It has proved very successful, and the idea may appeal to others.

I selected the best pair of old covers for experiment. They were a sorry pair—the canvas showing through large cuts in places. Then I picked out the next best pair and cut off the beads with a sharp knife (an easy job if the cut be held open after starting). Then the rubber and one outer layer of canvas were carefully cut across, and with help and two pair of pliers the outer layer of canvas and rubber were peeled off from the other portion, which I shall now call the liner, and which consisted of four or five thicknesses of canvas in more or less sound condition. The weak places in the liner were strongly patched on the outside and the edges of the liner were trimmed all round from inside to a thin edge with a sharp knife, so as not to chafe the air tubes. The insides of the complete covers were then cleaned with wire brush, and the liners put in and carefully placed so that each side was an equal distance from the edge of the cover. Then, with a brush three coats of ordinary rubber solution were put in, first one side and then the other, taking care not to displace the liner. I tried at first solutioning the cover and liner apart, but could not get the liner into position inside the cover so well. About half a pound of solution was required for each cover. When putting the liners in care should be taken to put the strongest and best parts to the weakest in the cover. Plenty of French chalk was put inside the covers before they were put on rims and blown up. Since this work was done the car has been in use each week-end, and has covered about 1,500 to 2,000 miles. For the last five hundred miles the tyres ran on the canvas of the cover; then I discovered large gashes right through to the liners, so took them off the wheels to save them for use with another pair of old covers. It may slow the car a trifle, although I have not noticed that the method does so, for the covers being so thick with liners do not require so much air pressure. It is a sound and safe job, for, if the cover itself should give, the tube cannot blow out till the liner is worn through, and there is plenty of warning before that happens. Of course, the covers do not look well on the car—literally they are in rags—but they run all right, and keep their shape well. To those to whom expense is a consideration I can recommend this method of using old tyres.—A.R.C.

How to Minimise Tyre Troubles.

178 We should recommend all novices to call at the nearest tyre depot and watch an expert take out a damaged air tube and put in a new one. If they see this done two or three times, and carefully follow every action and understand why a man goes to work in the way he does, they will have done something to dissipate their ignorance, but they have not done enough. Having arrived at this stage, they should go home and tackle one of their own tyres. They will probably pinch the air tube, bend the security bolts, or do something equally fatal at the first essay, but they will have made these mistakes with the minimum of inconvenience. They will have found out what to do and what not to do, so that when a roadside trouble with tyres does face them they will be able to go straight ahead and put in a new tube with certainty and despatch. Another thing which greatly simplifies tyre stops (of course, a spare wheel is the best remedy) is to have the tyre accessories all packed together; not the jack in one part of the car, the tyre levers somewhere else, the jack handle separately interred, and so on. Consideration of storage may not make it possible to have everything concerned in the manipulation of tyres in the same compartment, but if a little thought is given to the stowage of the spares, they can be got out much more quickly and put back with less labour than if they are simply bundled into the car higgledy-piggledy. Under these untidy and thoughtless conditions it will take almost as long to find the requisite tools as it will to change the tube after the tools are found.

Fitting Larger Tyres.

179 Very often when a motorist buys new covers, he considers the advisability of fitting larger covers than those originally fitted. We have advocated the practice ourselves, and still advocate it where the tyre makers recommend it. For instance, several of them make special 100 mm. tyres which are made to fit into 90 mm. rims, and so on. But when any drastic change is contemplated, the motorist should be careful to ascertain the opinion of the tyre makers, for it will probably be necessary to have larger air tubes as well.

In Case of Puncture.

180 In *The Autocar* a correspondent described how, in the event of a hopelessly damaged tyre, to get home without damaging the rim. His suggestion ensures, however, the complete destruction of the cover. The following

method was adopted by me, and saved both cover and tube: Having punctured both the tyre in use and the spare wheel tyre, and being unable, at that time of night (eight o'clock), to effect a repair, I walked to a neighbouring farmhouse and bought about 40ft. of ¾in. rope. After having removed the cover and the tube, I wound this round the rim, parallel with the direction of the car, until the whole rim was filled up and several layers of rope protruded. I need hardly say the rope was put on as tightly as possible. It was then lashed into place by some spare lengths of Bowden wire. I then poured some water on the rope, which drew it as tight as possible, and by this means drove to the nearest town (six miles) on the first and second speeds without in any way damaging the metal rim—in fact, the latter never touched the ground.—E. J. Boake.

To Remove Solutioned Patches from Inner Tubes.

181 When the tyres suffer from punctures, the chief trouble is to get the necessary patch to adhere to the tube if this method of repair as distinct from vulcanising be followed, but it is also necessary, at times, to remove such patches, and if the operation of repairing has been successfully performed, the removal is sometimes a matter of difficulty. An expert recommends the use of hot irons for the removal of any patches or bandages or rubber goods which have been stuck down by solution and not by vulcanisation. An ordinary domestic flat-iron immersed in boiling water for a sufficient time to heat the iron thoroughly is specially mentioned, as by this means the correct heat is obtained, and there is no fear of damaging the principal part. In the event of this method not being to hand, or a more convenient one being required, take a clean hammer head or other similar piece of metal, and heat this on the cylinder head, or, better still, on the exhaust pipe. To use the heated object, it should be held close up to the patch, or, if the heat is not too great, actually upon it until the whole of the patch and the surface of the main rubber is heated, when the patch or bandage may be easily peeled off without the use of naphtha or other rubber solvent.

Flare Patches.

182 Everyone knows the best way to make good the ravages of a puncture when on the road, apart from fitting a spare wheel, rim, or Stepney, is to put a spare tube into the cover, but there are times when the spare tube is lacking, and the following has been given to us as a method of

greatly shortening the time of effecting a repair, and, not only so, we are told it makes a better repair. The tip is to proceed as usual, so far as cleaning the tube and applying the solution are concerned. At this point, however, instead of a wait of a quarter of an hour or more while the solution is drying, a match is applied to it, and it is allowed to burn for a few seconds, not sufficiently to take hold of the rubber of the air tube, but to burn out the spirit in the solution. The patch is treated in the same way. A second coat of solution is given to each, and here again, in place of another fifteen minutes' wait, a match is applied again and the solution burned. Then without any further wait the patch is put upon the tube. It should be thoroughly pressed home, and, of course, the longer one waits before putting the tube in the better. Two flat pieces of wood, each about 7in. long and 4in. wide, may be carried. These can be put one over the patch and the other underneath. Then a hand vice, such as many motorists carry, can be screwed up upon the two pieces of wood, thus bringing a good pressure to bear upon the patch. Some little care must be exercised, as it is possible to give the tube too much pressure.

A Good Tyre Tip.

183 A tyre mystery which puzzles a good many people is the peculiar way in which one particular tube on a car will time after time get nipped or burst; sometimes nipping and bursting occur repeatedly with a succession of tubes on one particular wheel, and the suspicion is aroused that the rim of that wheel must be to blame; but tests reveal its accuracy. A case of the kind once came under our notice, which we successfully diagnosed and cured. It was the off-side driving wheel tyre of the car which the owner described as continually giving trouble, not from genuine punctures, but from nipping and bursting; repeatedly the cover would be found with one of its edges out of the rim, so that the air tube had burst through the orifice between the rim and tyre cover. This had occurred, although the cover had been taken off and interchanged with covers from the other wheels; no matter what cover was put on this particular wheel, it never seemed to fit securely. Careful examination showed that the wing nuts on the tyre-holding bolts were screwed up quite tightly, but we noticed that one of the bolts seemed to be shorter than the others, and by using a pair of pliers we found that the wing nut on this bolt could be screwed up by the use of some force to the extent of quite three-eighths of an inch more. Here was the explanation. The thread of that parti-

cular bolt was too tight a fit for the wing nut, so that, although the latter appeared to be screwed up as far as it would go, it was merely screwed up to the tight part of the thread, but the head of the bolt inside the tyre was not drawn down into close contact with the edges of the cover. Consequently, this bolt had been the cause of repeated failures, the edges of the cover slipping out from between the rim and the bolt, and sometimes nipping, and at other times bursting, the air tube. It follows that every tyre bolt should be suspected of similar imperfection, and the manipulator should not be content to screw the wing nut up as far as the fingers can turn it; but if the length of the bolt projecting beyond the wing nut is not what it should be, pincers or a spanner should be used to force the nut to draw the bolt down further, and the thread should be oiled.

Inner Tube Accidents.

184 One of the most frequent cases of damage to an inner tube is by nipping either between the edges of the cover or underneath the security bolts. It is imperative, therefore, that these points should be looked to very carefully in replacing the tyre. Unless care is taken in the manipulation of the tyre lever, this instrument is also liable to damage the inner tube, and this particularly when lifting the outer cover into place on the rim. The lever is inserted beneath the edge of the cover, and pushed into the rim to obtain a leverage upon it, so as to lift the cover into position. When in this position, unless the inner tube is lifted up so that the end of the lever bears upon the opposite edge of the cover, or upon the bed of the rim, there is every likelihood of its pressing the inner tube on to the base of the rim, so that the whole force of the lift is exerted on to the doubled-up portion of the tube beneath the inner end of the lever and the bed of the rim. When such is the case, it is almost impossible for the tube to escape damage. In order to obviate all possibility of damage by such treatment, instead of inserting the lever to such an extent as to reach the bed of the rim, it is better only to insert it sufficiently to rest just upon the edge of the rim, using that as the fulcrum instead of the base of the rim. With careful handling it will be found that it is just as easy to replace the cover with the lever in this position as in the other.

Security Bolts.

185 Great care should be taken to see that the holding-down bolts are pulled down squarely on to the edges of the tyre. On opposite sides of the bolt are two flats, which,

if kept parallel to the edge of the rim, will ensure the bolt coming down to its correct position.

Bent Security Bolts.

186 Creasing and crinkling of bolt heads is only one of the ailments from which security bolts may suffer. One of the commonest causes of trouble is the bending of the bolt itself. When the cover is levered off to insert a new tube one or more of the bolts may not be pushed up far enough into the tyre, so that when the cover is forced off it is quite easy to bend the stem of the bolt. This will not be noticed till the new tube has been inserted and the tyre cover put back into its place. Then it will be found impossible to pull down and bed into the cover any bolt which is more than very slightly bent indeed. It is no good deluding oneself with the idea that if the bolt is nearly down it will do; it is absolutely fatal to attempt to drive unless the bolts are all right home. When one finds that a bolt will not bed down it is far quicker to dismount the cover again and pull out the offending bolt than it is to leave it not quite bedded down. It will simply mean if the bolt is left in this unsatisfactory condition that the tyre will only run a mile or two before the bolt head punctures the air tube. If the worst comes to the worst and the bolt is too much bent or the head is too much creased, and no spare is available, the best thing to do is to take it out altogether. If the weather is wet the bolt hole or holes in the wheel should be plugged from the inside of the rim to keep out the damp and protect the tube from chafing on the edge of the hole. In fact, it is better to do this in any case. A piece of lead pencil will act as a plug, or a thick stem from the hedge with a piece of rag round it.

If there are five bolts in a wheel one can come home quite well on four, or even with three, whereas if the two bad bolts are put into the tyre the motorist will never reach home at all except on a deflated tyre. Of course, with the front wheels a couple of bolts are quite enough as a makeshift. Incidentally, this hint also conveys another, and that is, very great care should be taken in removing the cover and putting it back to see that the security bolts are not bent. It can be avoided if they are pushed well up into the tyre, and if in putting on or taking off the tyre levers are not used too close to the bolts. There is no need to use them just by the bolt, but it will be seen at once if the lever is pushed under the tyre near the bolt and it gets under the head, the stem of the bolt is sure to bend; and if bent, it will not pull down into the cover.

Creased Security Bolt Heads.

187 Among the spares which should always be carried on the car are half a dozen security bolts. This is particularly the case with those bolts which have flexible canvas heads. Some makes of tyres are turned out with almost inflexible security bolts, which are practically everlasting; but, unfortunately, this is not universal at present, and most of the flexible headed security bolts give trouble sooner or later. What happens is this. When the tyre is put on, the canvas head of the bolt is creased, or perhaps folded back in some way. It may run hundreds or even thousands of miles in this condition and give no trouble, but when the inevitable puncture does occur and a new air tube is fitted, the chances are a thousand to one that the creased bolt will never pull down properly into the rim, and it will be found that it will damage two or three air tubes in succession till one's stock is exhausted.

The only useful remedy is a new bolt, as it is usually impossible to get the creases and folds out of the old one. All users of tyres with flexible bolt heads should be very careful to examine all the bolts before putting in a new tube, and if they find any of them badly creased replace them by new bolts. If the old ones are soaked in water and carefully coaxed back to shape when half dry, they may be used again; but a lot of patience is required in reshaping them, and it may be said, speaking generally, that the result is hardly worth the trouble.

Worn Security Bolt Heads.

188 Your correspondents do not seem to have hit upon the obvious method of dealing with worn security bolts. On changing a tyre, I replace all worn bolts, and when I have half a dozen for repair I releather them, using slightly stiffer leather than the makers. I keep a supply of leather and canvas pieces ready cut, solution them well twelve hours before putting them on, then slip the canvas over the threaded screw under the bolt, the leather on the top, and the thing is done. It is both speedy and cheap.—LC 1934.

Security Bolts Close to Valve.

189 When retreaded tyres are used on the back wheels it will often be found that if they do not stand, the trouble is nearly always close to the valve, and it appears to be brought about by an attempt on the part of the cover to creep. With smooth covers a retreaded cover is little more likely to creep than a new one, but with grooved or studded

retreads the creeping tendency is certainly likely to be greater than it was before the tyre was repaired, as the new studs grip the road better than the old stretched edges grip the rim. However this may be, more often than not if a retreaded cover fails, it is quite close to the valve. The reason for this appears to be that the interval between the security bolts is greatest at this point in most wheels, as more often than not the valve itself is looked upon as a sort of security bolt. While it certainly does act in this way to some extent it does not grip the cover at all in the same way, and if there is an inclination to creeping the valve will suffer rather than the cover if the creeping is at all serious, but enough movement may take place to damage the cover very considerably without affecting (at the moment) the valve. We have tried the experiment of putting in a couple of extra security bolts, one on each side of the valve, and we have found it very satisfactory. The bolts have taken a good grip of the tyre at the very part where it was unsupported, and the result has been that we have been able to run retreaded tyres very much further without trouble. It might only be a coincidence, but in each case when the retreaded tyres failed, the makers assured us that it was due to creeping near the valve, and as we always keep our bolts absolutely tight, we knew that the creeping could only be prevented by adopting some extra security.

Cleaning-out Tyre Covers.

190 The vulcaniser at a local garage informed us recently that quite 20% of the tubes passing through his hands for repair showed signs of dirt having been dropped into the cover when one bead had been detached by the roadside, and having afterwards set up friction between cover and tube when the tyre was replaced. Consequently whenever a tube is changed by the roadside, before the new tube is inserted the interior of the cover should be mopped out from top to bottom on each side with a dry rag first of all ; the wheel should then be spun to loosen any road dirt or grit in its interior, and when one is certain that all foreign matter has dropped to the bottom of the cover at the lowest point of its circumference, that part of the cover should be carefully mopped out with a rag slightly damped. The cover may then be dusted with French chalk.

Burst Covers.

191 To make a temporary repair of a burst cover, if the burst is on the tread, we will remove the entire cover, wash out that part adjacent to the burst with some

petrol on a rag, and remove all traces of French chalk. A thick coat of solution is now applied right across the inside of the cover, say three inches each side of the burst; solution a piece of rubber or a tyre patch of suitable size, and when ready apply just over the burst. This will keep wet out. Next cut three or four pieces of solutioned canvas in progressive sizes, and solution both sides. The first piece will be somewhat larger than the rubber patch, the next larger still, the third large enough to cover all the others and extend from edge to edge. Now cut a piece of canvas a little thinner in texture, solutioned on one side only, wide enough to cover the previous pieces and long enough to come over the beaded edge at each side. It will be a messy job sticking them in, and perhaps you had better solution as you go on; but if you are in a hurry you can do as I say, and stand the doubly-solutioned pieces on edge to dry (they will naturally curl, and stand like a roll of linoleum). Of course, if you can spare the time, or are doing the work at home, vulcanising will make a much sounder job. I have a driving tyre which was so treated two months ago, and which has since done 700 miles. Recently it burst in another place, and lately that patch defied my efforts to remove it. Though I got one edge up with a knife and tried to tear it out with pincers, I only tore a piece of the original lining. For side bursts and torn-away beads there is nothing but the gaiter.—H. Scott Russell.

Fitting a Gaiter.

192 When a tyre bursts and no new cover is to hand, a gaiter may be applied outside the cover, and it should be fitted slightly out of centre with the burst. The object of this is to allow the gaiter to creep into its correct position as soon as the car has run a short distance. It is obvious that, especially if the gaiter is fitted to a driving tyre, there will be a tendency for the gaiter to creep a short distance, and for this purpose it should be set in the manner described. The lashing of the gaiter should be turned round the spokes at suitable distances apart, bearing in mind that the gaiter will creep in one direction, and so arranging the lashing to reduce this creeping as far as possible. In addition to a gaiter a similar device can be used inside the cover. Failing either of the above, the tube should be wrapped in canvas at a point coinciding with the burst, and the cover should be replaced, taking care that the canvas fully protects the tube. Before the tube is inflated, the tyre can be bound round with rope, so as to cover the burst part and protect the tyre at the weakest point.

The Spare Cover.

193 With interchangeable wheels or rims the question of the spare cover is now a more important question than it used to be. In buying a new car it is always necessary to buy an extra cover; and it is obvious, from the enquiries we receive, that a good many motorists are considerably exercised in their minds as to the sort of cover it is best to have for the interchangeable wheel or rim. If grooved tyres are used, we think it is best to have all five tyres grooved. If square-treaded back tyres are decided upon, it is best that the spare tyre should be square-treaded, too, because it will be much more frequently required on the back than on the front wheels. If studded back tyres and plain front tyres are used, the spare should be studded, but if all four wheels have studded tyres, it is best that the spare should be a plain cover, because there are certain times—very occasional—when studded tyres are not safe. We refer to the glazed state of the roads when frost has immediately succeeded heavy rain or when snow is in that condition that the studs will not hold. Under these circumstances it is much safer to exchange the plain or a grooved tyre and its rim or wheel with one of the front studded tyres, as driving when the front wheels refuse to grip the road is highly disconcerting, and the strange part of it is that, under the conditions which rob a studded tyre of its hold on the road, a plain rubber tyre will grip quite well.

Tyre Brushes.

194 When one has to change an air tube by the roadside, it is often very difficult if the weather is at all wet to avoid getting mud and grit into the tyre. Even in dry weather there is some difficulty this way, but it is easily overcome by the simple expedient of carrying a strong hard brush. In fact, a domestic scrubbing-brush is as good as anything, although there is another kind, with very stiff bristles with a handle a foot or so long, which is handier still. When the wheel is jacked up, it can be turned round, and all the dust or mud brushed off the cover and off the rim, so that when the tyre is opened, if the most ordinary care is taken, no grit or dust gets into it. There are a good many so-called porous air tubes, which have really become porous through the quantity of sharp grit which has been allowed to get into the tyre when roadside repairs have been carried out. The same brush is often useful, too, when a preliminary cleaning is desired to any part which is not easily scratched.

Mysterious Tyre Leakages.

195 Whenever it is necessary to replace a burst or punctured air tube, it is advisable before putting in the new tube to examine the nut which holds the valve to the air tube. Very often this nut shakes loose through continual vibration of the car, and also there is likely to be a slight contraction of the rubber between the nut and the valve seat, so that when it is required for use there is a mysterious leakage which cannot be traced to a puncture. Before putting the tube in it is advisable to try this nut with a spanner, and screw it down as tightly as possible.

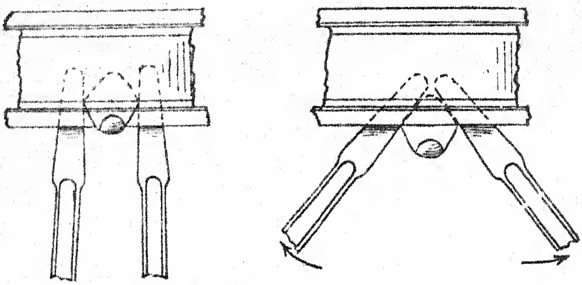
Repairs at Night.

196 Those who have suffered from tyre troubles after dark have appreciated the convenience of self-contained acetylene lamps, as they have been able to take these off and have a good light for the operation. However, nowadays a great many cars are fitted with lamps with separate generators. There are many points for and against the separate generator, but we do not propose to discuss them at the moment. So far as providing light for tyre manipulation at night the separate generator system is a failure, because the lamp cannot be moved any distance from the lamp iron. At the same time the remedy for this is a simple one. It is only necessary to carry a few feet of flexible rubber tubing, or, better still, metallic tubing with rubber connections at each end. Provided with this the lamp can be taken off its bracket and brought round to the scene of operations. The matter is so simple that we feel we ought to apologise for introducing it here, but one does not always remember these things till occasion arises, and we suffered some inconvenience lately through not being provided with the all-important flexible tubing. We managed to get through by means of a portable electric light. Had we been without this we should have fared very badly indeed, as both our side lamps and back light were electric, and, we are ashamed to confess, we had no spare cable.

To Remove Michelin Detachable Rim Clamps.

197 Simple as are the attachment and detachment of the Michelin detachable rim, there is, nevertheless, a right and a wrong way of performing even this simple job. When a rim has not been dismounted for about nine months it is sometimes found rather difficult to withdraw the clamps. Water, mud, dust, and rust have more or less cemented them

in their position, even though they had been—as they should have been—mounted with a good coating of vaseline. Now, violence or violent agents in the shape of chisels and hammers should not be used. The clamps can be persuaded to part company with the rim by a subtler method. Reference to the accompanying sketches is sufficient to show this. Upon meeting with a refractory clamp, all that is necessary is to take two thin-ended tyre levers, and thrust one on the right



How to remove Michelin detachable rims.

and the other on the left of the washer, between the detachable rim and the fixed rim, as far as they will go, keeping them parallel the while. This being done, the outer ends should be thrust apart in the direction of the arrows, when it will be found that the clamp will leave its bed between the rims and its place on its bolt quite easily. It is an easy and simple operation, and preserves the bolt from bending and the threaded portion from injury.

False Alarm of Puncture.

198 It sometimes happens that a false alarm of puncture is raised through a tyre suddenly going down. It is well, therefore, always to make sure that it is a puncture before commencing to change the wheel or to detach the cover. Very occasionally it will be only the valve at fault. This is particularly the case when a tyre has gone down gradually, and not with the sudden hiss that betokens the incursion of some intruding obstacle.

An Ancient Tyre Tip.

199 When touring in Italy M. Paul Meyan, owing to the exceedingly bad roads, had a great deal of trouble with his tyres. He practically ruined one set of covers; he then put on new covers, and used some old ones over them

as a protection, with very satisfactory results. Many motorists were interested in this, but have been prevented from trying the experiment, as it was understood that it was impossible to make a neat job of it unless they obtained old covers of a larger size, so that the old covers would go over the new ones without having the sides slit. An extract, therefore, from a letter sent us by a reader of *The Autocar* will be of very considerable interest and use : " An old and therefore stretched cover of the same initial size as the normal cover may be used by cutting off its edges and simply placing it over the latter when this is deflated, and then blowing up hard. The obvious extension of the idea was to sew straps to the old covers and secure these to alternate spokes in a manner that will suggest itself to anyone. I can assure you the result is most surprising and satisfactory. Any saddler can sew on the half-dozen or dozen straps for a few shillings, and the old cover so secured is perfectly firm. Even if it is badly cut, the cuts do not gape (though it is advisable to place canvas behind them), and, of course, there is no wearing surface equal to that of a properly vulcanised rubber one. Owing to the severance of continuity between the attached cover and the ordinary cover, puncturing objects that pierce the former are turned at the surface of the latter. I have a sharp nail 3in. long that was picked up at the first trial, pierced the outermost cover, and then simply passed in between the two for a distance of a couple of inches, where it was tightly held. I am convinced that this method of using up old covers will be more than a boon to every driver who makes use of it."

The Care of the Tyre.

200 Many tyre repairs are occasioned through carelessness, or, in some cases, a want of knowledge on the part of the driver. A fruitful source of chafing on the edge of the tyre is the habit of driving close up to a kerbstone. Even if a car runs a short distance along the edge of the kerb it will chafe the greater part of the diameter of the tyre. The sides of the cover have the least quantity of material to resist wear, as it is obvious that if these are made very thick they lose a lot of resiliency. Therefore, they are only made sufficiently strong to withstand the pressure to be put upon them. If by accident the sides of the tyres become chafed, it is always as well to have the damage repaired by the makers as soon as possible, as this is a comparatively trifling item in the first place, yet if it is left to go and more rubbing takes place, the canvas of the tyre will be exposed and subjected to wet,

and once the water has thoroughly impregnated the fabric rotting will take place very quickly. A very fruitful cause of damage is allowing oil to remain upon the tyres. We have seen many owners who are very careless in this respect. They allow oil to remain upon the floor of the garage, and drive their car in and out, when it regularly picks up grease. This is generally allowed to remain upon the tyre, with disastrous results. As all kinds of oils, greases, and the majority of acids have a deleterious action upon indiarubber, whenever any of these come into contact with the tyres, they should at once be thoroughly removed. If allowed to remain on the cover, the action of the oil is very slow, but equally sure. It softens the rubber, in the first place, making it into a spongy mass; then, when the air enters through the cracks, it hardens again, and so we get a bad cover, with rubber coming off it in more or less large quantities.

The Care of Tyres in Winter.

201 When the wintry weather approaches, advice as to the care of tyres on vehicles left stabled or garaged for considerable periods of time will be of use:

(1.) When the car is run but once a fortnight, or once a month, jack up the carriage so that the wheels do not support its weight, and the fabric liners are not continuously under stress. Four wooden tripods, shaped at their apices to take the front and rear axles at points close up to the wheels, are the simplest and least expensive means of doing this. It is not desirable to deflate the tyres.

(2.) When the car is out of use for several months. Before storing the car, it is advisable to take down the tyres and make a careful examination of the covers, inner tubes, and rims. If the first-named require repair of any description, this opportunity should be seized for having the work properly done. The covers should be scrubbed thoroughly free of all dirt, and after being dried should be examined for traces of wear or cutting. If the repairs necessary are beyond the skill of the amateur repairer, it is a good plan to send the tyres to their makers with an intimation that they are not required back in a hurry; the makers will then give more deliberate attention and more careful treatment to the requisite repairs than if they supposed that the utmost celerity were desired in returning the tyres to the owner. Tyres that are not in need of any repair should be scrubbed thoroughly with water, and after being dried inside and out, the covers should be coated inside with blacklead or French chalk and

hung up in a dark place. A cool storage is better than a hot dry place for indiarubber. Air tubes having been examined for possible flaws, and, if necessary, repaired, are best preserved by being inflated just sufficiently to make them assume perfect rotundity; they should then be hung up in that inflated condition. Spare tubes should be unpacked and similarly treated.

The Care of Rims.

202 Automobilists are sometimes inclined to be somewhat careless in many respects with regard to the rims to which the tyre covers are attached. Now it often happens that after running on a deflated cover, or as the result of any slight accident, the rim gets knocked slightly out of shape, causing the edge of the rim to have a certain cutting action on the beaded edge of the cover. The rims therefore should be examined from time to time by jacking up the car and turning the wheel round, making a close examination of the edge of the rim in which the cover fits. By this means the slightest dent or malformation of the rim is detected immediately, and once discovered it can be remedied in the following manner: If the edge has been knocked down or flattened, it is rather difficult for an amateur conveniently to repair it himself, but generally a competent blacksmith can put it right, with the aid of a pair of tongs. On the contrary, if the damage arises from slight bulges, they can be removed by means of a hammer carefully used in order to prevent denting in the rim. It must not be overlooked that these little attentions remove the paint from the rim, and it is therefore necessary afterwards to give the parts operated upon two or three coats of paint and varnish, as an unpainted or badly painted rim will soon rust, and a rusty rim will spoil more covers than anything else.

Rust in the Rim.

203 A cause of damage lies in the rusting of the rims. These should in the first instance be painted, and the tyres should not be put into position until the paint has dried thoroughly. In removing the cover from the rim and putting it back again, the paint upon the rim is certain to suffer more or less injury. The places where the paint is removed, both on the inner edge of the rim and on its outer edge, should not be allowed to remain bare for an indefinite period, but, as opportunity occurs, should be painted over with some air-drying enamel, having previously been cleaned up with a little worn emery-cloth. If the bare places are

allowed to remain and the water gets to them in running through the mud, rust sets up and eats its way into the canvas and rapidly rots away the fabric.

Water Admitted through Loose Spokes.

204 On dismounting a cover which had been for twelve months on the rim of a wire wheel, a ring of rust spots was found marked all round the circumference of each clinch, showing that water had penetrated the rim through the spoke holes. The wheel is perfectly stiff and tight under all ordinary tests, yet shocks have evidently loosened the spokes in their holes just sufficiently to admit water. It is impossible, apparently, to remove the rust spots from the clinch, and unless more water is prevented from entering, the clinch will gradually become rotten. The method employed is to enamel the inner periphery of the rim—that facing the hub—with two coats of a thick black enamel.—B.H.D.

The Value of French Chalk.

205 Motorists, when changing air tubes, do not always sufficiently appreciate the necessity for care in properly distributing the French chalk which they put inside the outer covers of tyres. The amount of friction between the inside surface of the outer cover and the outside surface of the inner tube is enormous, and the object of French chalk is to lubricate the two surfaces which thus come in contact. French chalk between these surfaces does not so freely distribute itself as oil between metal surfaces, so that it is necessary to spread it evenly, and not to put it on in little heaps. There is a most useful article on the market in the form of a big pepper box, which spreads the French chalk evenly. This is obviously a great advantage, for if the powder is put in heaps inside the cover places are left between the tube and cover where there is no chalk.

Clearing away French Chalk.

206 The French chalk within a tyre cover should never be washed out, although some professional drivers are very fond of so doing, because it is a quick and easy method of getting rid of it. But, like most proceedings that avoid trouble, it is a very undesirable thing to do, for the reason that it is seldom that sufficient time can be allowed to permit of thorough drying, and if there be any weak places in the fabric the moisture which penetrates them only serves to weaken them the more. The proper way to get rid of the spent French chalk from the interior of a cover is to brush it

thoroughly with a stiff brush, and then rub the inner surface well with a clean cloth dipped in methylated spirit.

The Preservation of Rubber.

207 The principal enemies of indiarubber are a strong light and changes of temperature. Strong light is particularly bad for any class of indiarubber, as its action destroys its elasticity by extracting the sulphur used in the vulcanisation. This is folloewd by a hardening of the rubber and the development of small cracks which let in more light, and eventually cause the rubber to peel off the fabric in quite large pieces. As to temperature, this has very much the same effect as strong light, although in not such a high degree. The temperature of a room in which rubber is stored should be about 65° to 75° Fahr. A higher temperature should be avoided; lower ones will not do any harm. It is obvious that one cannot choose the ideal storage for tyres which are in position on their wheels, and it is as well to note that the house in which one's car is stored should not be subject to great heat, or that the windows do not admit of rays of strong light being projected on to the tyres. Galvanised iron sheds, for instance, attract great heat in the summer time, and are very cold in the winter. They are particularly unsuitable buildings, therefore, in which to store rubber. One peculiarity of the tyre is that it is not so liable to decomposition from changes of temperature or the influences of light after it has been used as it is when new. Any spare tyres which may be kept should be stored in a room where as even a temperature as possible is maintained, and where they are free from strong lights.

For the preservation of rubber articles in store (*e.g.*, spare tubes), frequent washings with alkaline water should serve the same end. An alkaline bath may be obtained by mixing a little Scrubbs ammonia with water; the percentage of ammonia in asolution to be used as a rubber preservative may be much less than 50%.

Destructive Effect of Grease.

208 Beware above all things of allowing oil or grease to get and to remain upon the tyres. All fatty substances are detrimental, as they act as a solvent upon the rubber. This can be proved easily by rubbing vaseline upon a piece of an old cover. The vaseline will cause the rubber to become spongy, and when dry it will crumble, and can be rubbed into powder by the friction of the hand. It is most important, therefore, that the rubber of pneumatic tyres

should at all costs be protected against grease. A well-known tyre manufacturing firm tell us that they have had covers under their hands in which the stiffened edge has been rotted off completely by a neglected lubricator allowing oil to trickle down on to the tyre. Lubricators which are in positions likely to admit of this should, therefore, be frequently scrutinised. Also care should be taken that no part of the moving mechanism of the car throws oil on to the tyres. For the above reason, spare tubes should always be placed in rubbered cases whenever they are likely to come in contact with oil-cans, oily cloths, or tools.

Use the Brakes Carefully.

209 The costs for the upkeep of tyres of many car owners and drivers are no doubt increased by the way in which they apply the brakes, for if a car is proceeding at even a moderate pace, and the brakes are applied suddenly, they will entirely lock the wheels, preventing their rotation, or check them to such a degree that there is a dragging action caused by the momentum of the machine drawing the tyres over the surface of the road. The result of such treatment is that tyres do not last nearly so long as they would do if the brakes were applied gently. There are necessarily times when one has to put down all the brakes as hard as possible to prevent an accident, but such occasional applications are not sufficiently important to be considered in dealing with the upkeep and repair of tyres.

Periodical Examination of Tyres.

210 In the chrysalis stage, a tyre burst is generally a small cut in the rubber, although, of course, some bursts do take place immediately after the damage is done. We do not refer to the latter, but to those cuts which grow and eventually terminate in a burst. As stated, the cut is a small one, probably in the rubber alone. The tension on the rubber tends to deepen the cut, and it gradually gets deeper and deeper, until it reaches the canvas. The car is then used on a wet day, say, or during washing water gets into this cut, which, not being exposed to the atmosphere, does not evaporate. It slowly rots the canvas, and as this has to withstand a pressure of anything up to, and sometimes over, 80 lbs. per square inch, it will be seen that the action of the bursting stress on the inside and the rotting of the water on the outside is to break down the strands, and allow the air tube to push through. It will be seen immediately that very little more is required for the air tube to burst at this point,

causing, as is well known, considerable delay and expense, all of which can probably be averted if the cut is taken in hand when quite small.

Rubbing Tyres.

211 It is a very good plan to jack up the front wheels and then to put the steering wheel hard over, so as to give them full lock first in one direction and then in the other. When the road wheels are at the extreme lock, that is to say, turned as far to the right or left as possible, they should be revolved to see whether the tyres touch the frame, the springs, or the brackets which hold the mudguards. If the tyres rub on these or anything else, it means that they will be damaged whenever the helm is put hard over. In many cases it will be found that by having the mudguard brackets taken off and reset to a slightly different shape by a blacksmith, proper clearance can be given; or if this cannot be done small hard wood rollers may be mounted on the frame to take the rub of the tyre, and to keep it from actually touching anything but the road. It is also well to examine the back guards carefully for the same defect. The trouble here is, of course, quite different from that at the front. What generally happens is that the mudguards are placed rather too close to the wheels, and consequently when the car is fully loaded and running on an uneven road, the wheels, or rather the tyres, bump against the guard or its supporting bracket. It is generally the bracket which does the harm, especially if there is a projecting nut or nuts. These projecting nuts occasionally do very serious damage indeed to the covers, as they cut large pieces out of them, and in extreme cases we have seen gashes a foot or more long caused in this way. The remedy is to get a smith to set the wing brackets higher.

Inflation Pressures.

212 It is with no trepidation that the writer expresses his views upon the subject, even in face of the high speed tests made on prepared tracks with cars either racing, or if touring cars, so stripped and prepared beyond recognition that they are a law unto themselves. If the tyre is not pumped hard enough the lateral stress will have a tendency to drag the tyre off the rim, and if the fitting between the rim and tyre is close enough to avoid this, the lateral rolling motion will in all probability tear the sides of the cover away from the beaded edges; hence the greater the weight carried by each wheel the higher must be the inflation

pressure. It should not be forgotten that a tyre may appear to be sufficiently inflated during a period of rest, but when the car is travelling, the wheels, passing over uneven surfaces, have to surmount stones and other obstacles, also to drop into holes, causing the wheels to bump, which has the same effect as if a blow had been struck, and for the time being considerably increasing the outside pressure upon the tyres. Therefore, it is necessary that tyres should be so inflated that the compression provides against such contingencies. Tyres are oftentimes run by users half inflated, and there is nothing more destructive to the life of a tyre and the durability of a car.

With regard to the actual inflation pressures employed, commonsense must be used. All the tyre makers issue tables of pressures for different sizes of tyres and different weights of cars; but, owing to the fact that so many people are careless as to the tyre pressures, the majority of the tyre makers recommend somewhat higher inflation pressures than are actually necessary. Therefore, if the pressures specified are found to make the car uncomfortable, they should be somewhat reduced. It will be noticed in all these lists that the larger the tyre and the less the load, the lower the pressure required, and it follows, therefore, that a car with relatively large tyres is the most comfortable because it can be run at low tyre pressures.

The rule of thumb for blowing up tyres is a great error, and, looking to their value, it is wonderful the risks users run. It is so easy to over-inflate or the reverse in these circumstances. Money is well invested by the purchase of a pressure gauge, by which the owner of a car can at a glance see the pressure. Many motorists (particularly chauffeurs) flatter themselves that they can tell the right pressure by the appearance of the tyre when the weight of a car is upon it, but let them test such an opinion by the use of a pressure gauge test, and it will usually be found that they were greatly out in their calculations. If a gauge is not available, the tyre may be pumped up in the ordinary way, and then to test if it is sufficiently inflated let it take the car weight. Rock the wheels in a lateral direction, when no side roll should take place, and at the "ground contact" there should be no bulge.

Mounting Studded Tyres.

213 If those studded tyres which have leather treads are examined, it will be found in the majority of cases that the leather band overlaps at the joints or joint.

Sometimes one joint overlaps one way, and the other in the opposite direction. When this is the case nothing can be done; but in the majority of cases the joints overlap in the same direction. When this is the case the life of the band can be very considerably prolonged by the simple expedient of putting the tyre on so that the joint runs with the wheel and not against it. It is only necessary to remember the direction the wheels of a car revolve when putting on a tyre. From our experience we should say a very considerable difference in the life of a band is made, as we have destroyed one very rapidly by a neglect of the precaution.

The Blue Pencil.

214 A small piece of copying ink pencil is a useful addition to the repair outfit, and its presence is appreciated when one has to deal with small punctures which are difficult to find. A ring drawn round the puncture after cleaning will denote readily its position, and ensure the patch being centred over the hole.

Tyre Pump Washers.

215 The majority of tyre pumps are still made with leather plungers, which plungers make or mar the pump, according to their condition. When the pumps are new, the washers are lubricated with vaseline, and compress every atom of air that is sucked into the pump, and expel all of it into the tyre. The pump barrel gets so hot in process of pumping up even a 90 mm. section tyre that it will burn the operator's hand. This heat reduces the vaseline rapidly, until at last the leather plunger is left practically dry and shrivelled, and forms a very bad fit in the pump barrel. The pump then inhales far less air on the suction stroke, and on the expulsion stroke a large proportion of the air leaks back up past the plunger, so that a huge number of strokes are required to give even a moderate rotundity to the tyre, and it becomes absolutely impossible to pump the tyres up to any high pressure. The leather should therefore receive attention proportionate to the use the pump is called upon to bear. New plungers are never necessary if vaseline is frequently applied, but in emergencies an excellent washer may be cut from the tongue of an ordinary walking boot, treated with grease from the gear box. The dryness of these plungers is responsible for the return of many a pressure gauge as faulty, for the buying of new pumps, and for much futile labour.

Wooden Wheels out of Truth.

216 Some difficulty is experienced occasionally by the so-called artillery wheels going out of truth, either circumferentially or laterally, or both. When a wheel is noticed to be so affected, it should be attended to immediately, otherwise it is quite possible that it may be followed by an entire collapse. Retruing is a thing which cannot be attempted by the ordinary repairer, and must be put into the hands of a competent carriage-builder who makes his own wheels or who can get them trued up by a firm which makes a speciality of wheel-building. This going out of truth is caused chiefly by the wheels being built up with imperfectly-seasoned timber, which is greatly affected by atmospheric changes, causing fluctuations in the tension upon the wheel. This will expand in wet weather, while in dry seasons it contracts and tends to split apart at the felloe and at the junction of the spokes with that part, despite the fact that the whole is bound by the iron rim of the tyre.

Testing Road Wheels for Alignment to Save Tyre Wear.

217 From time to time we have referred to the extreme importance of keeping the road wheels in line, as any absence of alignment results in rapid wear of the tyres, besides wasting power and affecting the steering of the car. Of course, the degree of needless wear to the tyre, the amount of power wasted, and the effect upon the steering are proportionate to the inaccuracy of the wheels. There is no such thing as absolutely correct alignment, but something very nearly approximating to it must be obtained, and retained, if the tyres are not to be unnecessarily worn away.

In the course of their very long experience as tyre makers, the Palmer Tyre, Ltd., have seen so much needless damage done to tyres that they have made a study of the subject. They have found many instances of undue wear to tyres, for which the users not unnaturally blamed them, were really due to the wheels of the car being out of line, so that the tyres were dragged over the road, instead of being rolled along it. The makers of the Palmer tyre recognise quite well that the average owner has not the necessary appliances or staff for easily testing alignment, and therefore they have devised what, for want of a better term, we may call a one-man method of ascertaining whether the wheels are all in line and that without the necessity for any but the very simplest appliances. The procedure is clearly illustrated in fig. 1. Two strips of wood, each about 7ft. long, should be procured.

Holes should be drilled near the ends exactly the same distance apart, and the two strips of wood should be connected by two equal lengths of string about 15ft. long. An ordinary chair is then placed in front of the car and another at the back, and the strips of wood are arranged across the chairs, and adjusted so that one of the strings is exactly parallel with one of the rear wheels. Whether it is parallel or not is ascertained by measuring the distance between the string and the rim of the wheel at opposite sides of its circumference. The other rear wheel should then be exactly parallel with the other string. If it is not, it means that the rear axle is bent, the wheels out of truth, or the axle has shifted along the springs; or, in the case of a chain-driven car, it has been

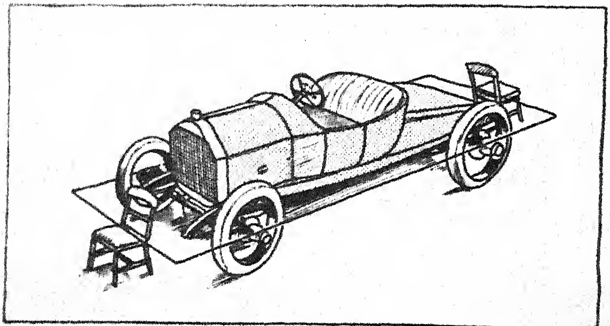


FIG. 1.—Testing wheel parallelism.

unequally adjusted. Having ascertained the parallelism of the rear wheels, one of the steering wheels should be set so that it, too, is parallel with the string, the string, of course, on that side remaining parallel with the back wheel. Having done this, the steering wheel on the other side should be found in correct alignment also. As the rims are not always quite true, it is advisable to move the car sufficiently to cause the wheels to make a quarter of a revolution, and then to repeat the whole of the measurements. If any marked discrepancy is found, the truth or otherwise of the rim can at once be ascertained by jacking up the car and spinning the wheel.

It will be seen that this simple method of testing the alignment cannot fail, because the two strings are parallel with each other, as the holes in the strips of wood are exactly the same distance apart. Therefore, as the two strings are parallel,

it follows that if one string is adjusted to be parallel with one of the driving wheels, and the steering wheel on the same side is also set parallel with the string, the two wheels on the other side must be parallel with their string, and if they are not the wheels are out of alignment, and the defect should be remedied. It should be borne in mind that occasionally the front wheels are rather closer together than the back. That is to say, the track in front is slightly narrower than the track at the back. This, of course, can easily be allowed for in making the measurements.

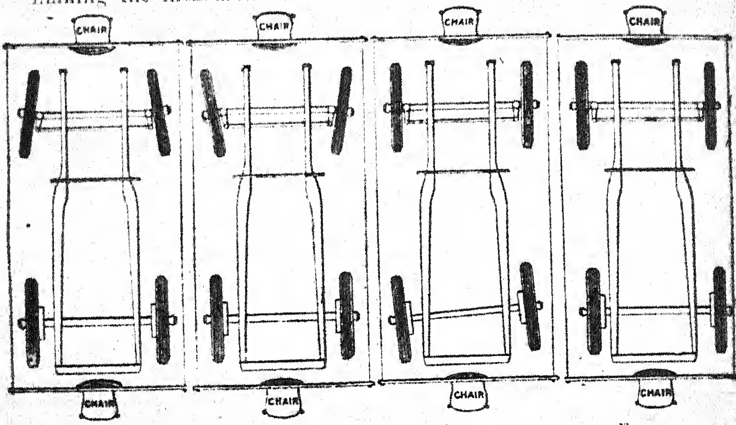


FIG. 2. FIG. 3. FIG. 4. FIG. 5.

Various examples of lack of alignment, with strings, etc., in position.

Figs. 2 to 5 show the errors in alignment which are most common. Each of the figures is a plan view, and fig. 2 shows the common defect of the connecting rod being too long—that is, if it is placed behind the axle; if in front it is, of course, too short. Fig. 3 shows the same defect in the opposite direction, and the cause is due to bad fitting after manufacture, or to the rod which connects the two wheels having been bent in some way. The error shown in fig. 4 is most common on chain-driven cars, and is due to careless chain adjustment, so that one end of the axle has been pulled back further than the other. It is also occasionally present in gear-driven cars, and caused by careless adjustment of the radius rods, if radius rod adjustment is provided, or it may be due to the axle moving in the spring clamps, though, of course, in properly constructed cars such a movement is impossible.

Fig. 5 only occurs when a car has been carelessly erected or has been in some serious collision or subjected to some extraordinary strain, so that the frame itself has bent or the axles have moved bodily sidewise in the spring clamps. It is most unlikely such a defect would pass any but a criminally careless manufacturer, and it is rarely found except when a car has been in some accident.

By far the most common defects are those shown in figs. 2 and 3, and they are so common that it almost seems as though the coupling rod between the two wheels should be made adjustable. It is made adjustable in one or two cases. When it is not, the only remedy is to have it very carefully heated and bent by a good smith, the greatest care being taken that the ends or eyes are not set out of their proper position in any way, otherwise they will bind badly upon the steering pins. When any difficulties arise in finding out just where the lack of alignment lies, it can generally be ascertained by measuring and comparing the distances between the centres of the back and front wheels on each side of the car, and also by measuring the distances between the wheel rims and the frame.

As to the rear wheels, unless the frame is bent it is usually easy to set them right by means of the radius rods, but, of course, in the case of a defect like fig. 5, and assuming that the axles themselves were all properly positioned on their springs, the only possible remedy would be to have the car dismantled and the frame trued by a firm of competent motor engineers. The Palmer Tyre, Ltd., advise all owners of cars to test their wheels in this way from time to time, and even to test new cars when received, as they tell us they know of cases in which new cars have been found to exhibit the defect shown in figs. 2 and 3 in a marked way, so that directly they were put into use they commenced to scrape away their front tyres.

Shrinkage of Road Wheels.

218 A spell of dry weather often causes wood wheels of motor vehicles to shrink at the naves and the felloes, and particularly on live axle cars this is rather likely to prove trying to the wheel's stability if not attended to. A good plan to prevent excessive shrinkage is to take a rag and soak it well in water; then wrap it about the nave of the wheel where the spoke wedge centres fit up together. This will effectually prevent shrinkage at these points. At the felloes wet rags should be placed in the same manner,

or the wheel should be frequently douched with water, but in the latter case, after the wetting the tyres should be wiped over to dry them, otherwise there is a tendency to cause rotting of the canvas by the penetration of water through any cuts in the rubber or through places at the beading where the water can penetrate.

On Inner Tubes.

219 The question of "unexpected tyre troubles" having arisen in the correspondence columns of *The Autocar*, more especially with regard to the peculiar behaviour of air tubes under certain conditions, a few moments' consideration on the best method of storing tubes when not in use may be of interest.

The function of the inner tube is too well known to call for comment; suffice it to say that the inner tube forms the essential part of the tyre as a whole, and little examination is required to note that its structure differs largely from that of its protective sheathing, the outer cover.

The material of which the tube is composed contains a very large proportion of pure rubber treated in such a fashion that certain desirable qualities are developed in order to fit the product for use on the car. This process is known as vulcanising—an incomplete reaction in the case of rubber for motor use. Complete vulcanisation of rubber results in the formation of a hard brittle substance, and just as the vulcanisation of motor rubber is an incomplete process, so is the resultant product an unstable article.

The main factors in the deterioration of rubber tubes are heat and light, hence the necessity of renewing the water joints from radiator to engine (here, however, the action of the metal on the rubber is also to be taken into account), and the perishing of gas tubing from generator to lamps.

Rubber tubing in a state of retrogression is well seen in the case of the connection, say, to a gas bracket; after a time the tubing becomes hard and porous and cracks readily. Here again there is also the dialytic action of the coal gas on the rubber to be considered.

Surgical rubber, which is practically identical with that of inner tubes, is kept loosely coiled in a glass vessel filled with water to which an antiseptic has been added, the whole then being stored in a dark place in an equable temperature. The result is that the rubber keeps its good qualities for an indefinite period, and, as a matter of fact, tubing has been recovered in good condition from the wreck of a ship which

has been submerged for over five years in sea water. Similarly, the rubber bags used by anæsthetists very readily become deteriorated and hard when not in use, but the application of tepid water soon restores the pliability and elasticity in a marvellous fashion.

On reading the above one is tempted to remark that we cannot carry large glass vessels in the car or keep them in the motor house for the express purpose of storing inner tubes in good condition. Quite so, but we can at least get a hint from the foregoing as to the proper storage of soft rubber articles.

As we receive the tube from the maker, we find it neatly folded in a box. This folding is wrong practice to start with. Soft rubber goods should always be stored so that their shape conforms to that taken up while in use—that is to say, circular goods should be kept circular, not folded. The maker's box arrangement is, of course, the most convenient method of sending out tubes, but if the tube be not for immediate use it should be taken out of the box, partly inflated, and hung over padded supports in a cool, dark place, and sponged with water occasionally.

The methods we employ in carrying the spare tube on the car do not as a rule help the tube much. We place the tube in a neat little waterproof bag, folded into the smallest possible space, and ofttimes it is permitted to lie as a spare (dependent on the luck we have with punctures) for months on end. Is it reasonable to expect that after the folding process in a bone-dry atmosphere for such a long time rubber should be fit to fulfil its function ?

Many inexplicable tyre troubles have their origin in minute cracks which start along the margins corresponding to the folding of the tube, and these can be prevented in a large degree by systematic examination of the tube. We set aside a day here and there for various little jobs in connection with the car—one day for the gear box and back axle, another for the valves, so why not an occasional day for the air tubes ?

Spare wheels and rims have done much to lengthen the life of the spare tube, for it is at least in its proper shape when inflated on a rim or wheel, and will suffer no harm as a rule. Take, for example, the case where the car is fitted with a spare wheel. For touring purposes at least one extra tube is usual, and if it be not necessary to use this extra tube it should after each tour be taken out of its bag, inflated, sponged, and hung up as previously described. For ordinary running about the extra wheel only need be carried.

It must also be remembered that waterproof bags are not oil and friction-proof, so that the location of the tube on the car should be considered ; the tool-box is no place for a tube either in or out of a bag.

Inner tubes also deteriorate as a result of nefficient repair. If the method of vulcanising by heat be used, it is well to remember that much harm may be done to the parts surrounding the puncture or burst by a faulty understanding of the process. It is not an unusual experience to have a burst repaired (?) by vulcanising, and a goodly portion of the neighbouring part of the tube "over-cooked" ; this may also account for some of the inexplicable tyre troubles.—PAGE.

Carrying Spare Tubes.

220 Many motorists do not take sufficient care of spare air tubes when these are carried on the car. Quite a number of times recently we have seen spare tubes loosely thrown into the tool-box, unprotected from oil, grease, and the sharp edges of loose tools. Spare tubes should be carefully rolled up flat, the interior valve parts having been removed, so that all the air may be forced out ; the valve parts should then be replaced and the tube packed away in a grease-proof bag containing a good sprinkling of French chalk.

In carrying spare tubes in a waterproof bag, see that the large thimble cap to the valve is not screwed on so that the pin in the dust cap projects beyond it, otherwise it will perforate the tube sooner or later. Some caps cover the pin completely.

The Economy of Two Spare Wheels.

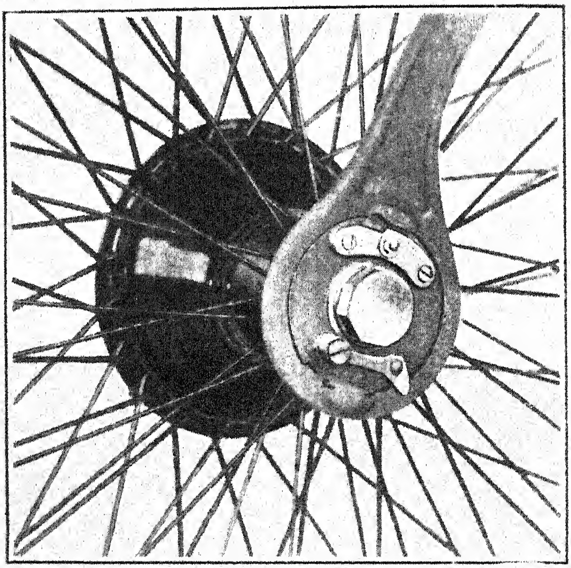
221 Nowadays detachable wheels are so widely used that the suggestion of an owner of a car with Rudge-Whitworth detachable wheels will be interesting to many. It should be understood he does not claim novelty for the suggestion, but he has found it work well in practice, and thinks it is worth while to draw further attention to it. When he first had his 38 h.p. car he had the usual equipment of five wheels complete with tyres ; but on the recommendation of his chauffeur, who had carefully watched the wearing of the tyres, he bought a sixth wheel and tyre so that his equipment in this direction consisted of two plain rubber tyres for the front wheels, two metal-studded tyres for the back wheels when the roads were bad, and two ribbed-rubber tyres for the back wheels when the roads were good. This equipment, combined with the readily detachable wheels, enabled him to suit

his tyres to the conditions of the day. On a muddy day, when the roads are likely to be greasy, one or both of the wheels with studded tyres are taken from their brackets and put into use, and the rubber-tyred wheels carried as spares. On a dry day the procedure is reversed. The result has been to effect economy in all ways, as every motorist knows that studded tyres wear more rapidly than rubber-tread tyres. Further than that they are less efficient tractively, so that the car runs better and uses less petrol on rubber treads than on the metal-studded variety. The matter does not end here, however, for little as they may damage the roads there is no question that studded tyres are harder upon them, as well as upon the car, than rubber tread tyres, so that the matter may be summed up in the statement that six wheels are better than five, and that if a metal-studded tyre be used it is better to have it on the spare wheel and only to bring it into use when actually required. Incidentally, we may mention that, on the whole, when two studded tyres are used out of four we find it better to have one studded tyre on the inside back wheel and the other on the outside front wheel, rather than to have two studded tyres on the back wheels, and two plain ones on the front. This practice can, of course, only be carried out in its full economy when six wheels are available.

A Detachable Wheel Tip.

222 To save slight extra trouble at the moment there is a temptation for drivers when testing their Rudge-Whitworth wheels to abuse the hand-operated bolt. They know well enough that the right procedure is to swing the bolt back, and not to have it in its locked position at the same time as the spanner is on the hub. In other words, the correct procedure is to throw out the hand-operated bolt, and then to tighten up the wheel on the ratchet bolt alone. When the ratchet comes up into the "safe" position the spanner can be removed and the hand-operated bolt put into position. However, the spring ratchet may occasionally stick, so that in using a mallet to tighten up the hub it may be necessary to take the spanner off two or three times to try the hand-operated bolt before it will fit into the locked position. Now to save this trouble some drivers are actually using the hand-operated bolt as a ratchet bolt. That is to say, they swing it round so as to put the spanner on and then put the bolt back. They do not bother whether the spring ratchet comes into the "safe" position or not, as they know that if the hand bolt be locked the hub is quite safe. However, some go even further than

this, and, most reprehensibly, do not trouble to swing the bolt back to the unlocked position while taking off the spanner. They simply wriggle or force the spanner off anyhow, and as often as not bend the hand bolt so that it never registers again with its spring pawl, unless it is removed and straightened. The spanner should never be on the hub unless the hand-operated bolt has first been swung out of the locked position into that indicated by the white dotted lines on the photograph reproduced below.



The spanner in position on an R.W. wheel; hand-operated bolt in wrong position.

Rusting-on of Detachable Wheels.

223 In the days of the now obsolescent fixed wheel, every practical owner knew that he must remove the hub cap and inject grease periodically; but many a proud owner of a set of detachable wheels imagines that the days of hub lubrication are over. But, of course, hubs need lubrication as much as ever they did, and more so in the case of sundry types of detachable wheel, which have orifices on both sides, through inspection holes, driving dogs, etc. Water is

bound to attack the hub of a detachable wheel, both in bad weather and whenever the car is washed; unless this water is guarded against, the two portions of the hub may rust up solid, and the detachable portion may prove immovable, just when the presence of a brace of spare wheels on the car has caused the tyre repair box to be left at home.

Detachable wheels should be removed for lubrication of the hubs every three months, and a wheel should never be fitted without thorough lubrication of both fixed and loose hubs. The lubricant employed must be such that it does not carry water, and of oils ordinarily available, castor oil is as good as most. Grease is not to be recommended, as when the wheel is screwed home it compresses the grease into a solid wad, which probably prevents the locking device engaging to the full. If grease be packed into the hub of the spare wheel to prevent rattle in travelling, it should be scooped out before the wheel is put on an axle, and castor oil should be substituted.

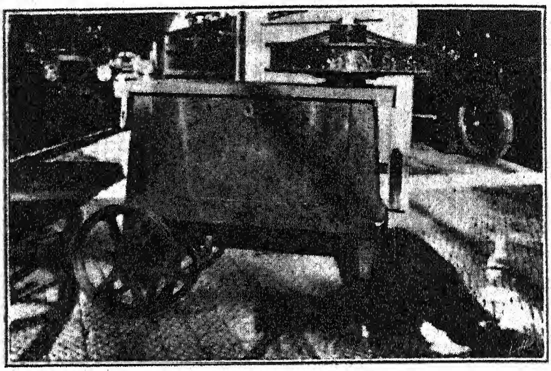
Danger of Jack Slipping when Changing Wheels.

224 Clumsy work during the process of changing a detachable wheel was the cause of serious trouble to a fine car. A small, narrow-based jack had been screwed up under a portion of the front frame, and the wheel with the punctured tyre had been removed. The side brakes were not applied, nor were any of the wheels scotched, and the spare wheel was left on its brackets until the other wheel was removed from the axle. In taking the spare wheel off its brackets, the car was inadvertently jogged a trifle, and immediately it slid off the jack, and one end of the front axle came down bang on the road. It was a very awkward job to get the axle lifted again, and when it was safely on the jack once more, it was found to be so bent that the wheel could not be fitted. It follows that when a detachable wheel is to be changed, the brakes should be applied, and the car stopped on a level patch of road free from excessive camber. The wheels should then be scotched, and the spare wheel laid ready to hand before the other wheel is detached.

Dummy Hub for Garage Use.

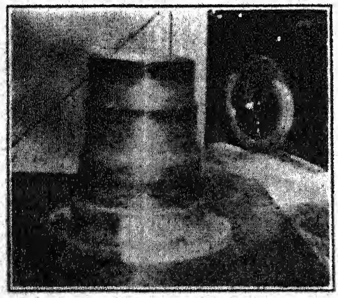
225 While it is recognised that the Rudge-Whitworth interchangeable and detachable wheels afford a most convenient and expeditious method of avoiding delay on the road through tyre derangement, it is also recognised that the damaged tyre upon the spare wheel must be attacked as soon as home is reached. Now it is quite simple to take off the cover and put in a new air tube, but it is rather an inconvenient

and back-breaking job. One remedy is to have a dummy hub upon which any of the detachable wheels will fit fixed to the wall of the garage at a convenient height; but a still better, because on the whole a more convenient, arrangement has



The wheel on the dummy hub of the work bench.

been adopted by Mr. F. C. Hunter, a well-known Devonshire motorist. It will be seen that he has had a dummy hub bolted to a portable bench. The smaller view shows the dummy hub, upon which any of the detachable wheels will fit, and the larger view shows the portable bench complete with the dummy hub at the end of it. We illustrate this portable bench because it is a most convenient thing—one which is well known in workshops, but not well known to the majority of amateur motorists. It will be seen that there is a vice at one end, and underneath a lock-up cupboard, in which special tools, such as drills, spanners, files, etc., may be kept. It is not only a great convenience to be able to move it just where it is required, but it is pleasant in fine weather to be able to take it out of the garage into the sunshine and to work there.



A Stepney Wheel Tip.

226 Sometimes when a spare wheel has been put on hastily, there may be found difficulty in fitting one of the two creeping straps with which all the larger sizes of Stepney wheels are provided. One pair of studs may come almost opposite to a spoke, so that it is a matter of a moment to slide the buckleless strap round the spoke and over the studs, but the other one may not be in a convenient position, and it may be impossible to get the strap on without loosening the two adjustable lugs of the Stepney wheel. Much the simplest way to put on the second strap is to drive the car for half a mile, and then dismount and fit it, when it is only the work of a second. The spare wheel will have then moved to the limit allowed by the one creeping strap, and the relative positions of the road wheel spoke and the two strap studs will have altered, so that there will now be not the least difficulty in slipping the other creeping strap into its position Then everything will be secure, and one can drive freely without further fear that the wheel will move out of position. For lower-powered cars the Stepney wheel has only one creeping strap, and, of course, to these the above remarks do not apply.

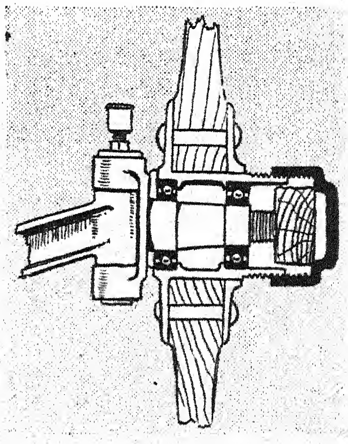
Fitting Stepneys Single-handed.

227 There are many who experience a difficulty when fitting a Stepney wheel single-handed, and in my experience this difficulty is much increased when a reinforced air tube is in the tyre on the car wheel. On two or three occasions in such cases I have had to take off both the cover and the air tube which were damaged, before I could get the Stepney in position. I have now got over this difficulty by carrying two cramps such as carpenters use. After placing the Stepney against the car wheel with the fixed clips at the top, I fix one cramp half-way between two clips, and make use of the screw by forcing the two wheels together until the clips are pressed into position on the rim. In a similar manner the second cramp is used half-way between the two adjustable clips. For 90 mm. tyres a 7in. cramp is sufficiently large. The difficulty is due to the fact that the tyre which has received damage will not, without a considerable amount of force, leave its position in the hook of the rim, and without the cramp one is compelled, not only to force the bead back, but to take the weight of the Stepney wheel in addition. —W. CROSS.

Loose Wheels.

228 Even when there is no apparent necessity for it, it is always advisable to jack up each wheel of a car and see whether it has much play. Almost all wheels have a little on their bearings, but it should never be allowed to become excessive, as it may easily develop into very great danger. Nowadays nearly all cars have ball bearings to all wheels, and these bearings when new are practically without any play at all. After a period of use some slight looseness occurs, but they should run for many months on a well-built well-tended car without becoming noticeably looser. On the other hand, a ball or balls may break or a bearing cup or ring may fail. The car will still go on running without any noticeable diminution of its speed, but the bearing may be cutting itself all to pieces with the broken bits, and eventually the whole of the side strain of keeping on the wheel may be thrown upon the axle nut, which in a good many cars means to all intents and purposes upon the split pin which holds the axle nut. Therefore the thing to do is to examine the wheels periodically, and if the play of a wheel upon its axle has increased materially since the last examination, the wheel should be taken off and the bearing carefully examined.

Removing Fixed Wheels.



229 It is occasionally necessary to take off wheels which are known as fixed wheels, though, of course, all wheels are necessarily detachable, otherwise a car could not be taken to pieces. We mention this so that what we are about to say cannot be mistaken for a hint referring to any but the ordinary so-called fixed wheels.

As there are various methods of securing the wheels, a hint of this sort will not apply to all, but we have found it useful on two or three different makes when unprovided with a wheel extractor. It will often be found that, after the big cap nut, the lock-nut or split pin,

and the axle nut proper have been removed, the wheel remains fast upon its axle. It would be easy enough to pull it off with an extractor, but without one it becomes a matter of difficulty unless more or less brutal treatment with a hammer and block is resorted to. We have overcome the difficulty by using the wheel cap as an extractor, *i.e.*, by putting a plug of wood into the wheel cap between it and the end of the axle shaft, and then gently screwing up the cap. It will be seen at once that this has the effect of forcing the wheel off the axle. As we have said, constructions vary, but this principle is quite obvious, and can be used for quite a number of different cars with a little modification.

There are two things to bear in mind:

1. That the axle cap must be a good one. Some caps are made of poor castings, and are turned so thin that they would burst if used as described.

2. That the packing between the end of the axle and the inside of the wheel cap must not be too thick—that is to say, the wheel cap should get a good grip on the threads of the wheel before it begins to bear upon the packing.

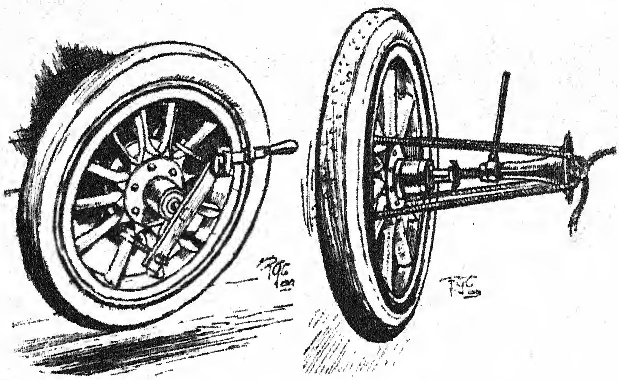
Using a Home-made Wheel Extractor.

230 The illustrations on next page show two makeshift methods of removing a wheel which has become very tight on its bearing or shaft. Either one or the other of these plans is far better than attempting to drive the wheel off by blows with a hammer on the brake drum or inner flange of the hub.

In the first method shown the materials required are: Two pieces of flat iron, each drilled with one ⅜in. hole, one long piece of the same material drilled at each end, two long ⅜in. bolts and nuts, and one piece of steel or bolt about 2in. in length and ⅜in. diameter. This latter should be interposed, as shown in the sketch, between the long iron plate and end of the axle. When the nut securing the wheel to the axle has been removed the outfit should be placed in position as shown, a performance often requiring two pairs of hands, and the nuts tightened with the fingers until the short stub bolt will hold in place. Then a wrench must be used, giving each nut a turn alternately. Unless the wheel be jamming badly, there should be no difficulty in removing the wheel in this manner without the necessity for using a hammer. If, however, the wheel be jamming badly and tightening up the nuts merely bends the long plate, one or two sharp blows at the back of the hub as near the centre as possible should move even the most stubborn

wheel. A similar method may be employed to "draw" a flywheel from a crankshaft.

The second illustration depicts an alternative method which has been used with success on occasions when the details required by the first method have not been available. A length



of stout rope, the car jack, and a short piece of steel or a bolt, as before, are the only requirements. The sketch is self-explanatory, but, simple as the method is, it is none the less effective in the majority of cases.

PETROL AND TANKS.

A Common Cause of Poor Climbing.—Filler Cap Leakage.—Engine Starved of Petrol.—Petrol Tins in Hot Weather.—Carrying Spare Petrol.—A Cheap Petrol Gauge.—Water in Petrol.—An Exhaust Pressure Feed Trouble.—Protecting Pressure Feed Tanks.—Tank Pressure without a Pump.—Petrol and Oil Strainers.—Area of Gauze Strainers.—The Necessity for Fine Petrol Strainer Gauze.—Caps for Spouts of Petrol Funnels.—Leaking Petrol Tank.—On Repairing Petrol Tanks.—Breakages of Petrol Pipes.

A Common Cause of Poor Climbing.

231 We cannot help thinking that enough attention has not been given to the question of a full petrol supply when a car is climbing steep and fairly steep hills. In the course of our experiences of all sorts of cars up hills we have often been unable to account for the comparatively disappointing running of certain engines. An engine may have done exceedingly well on the level and up moderate slopes—more than sufficiently well to show that the engine was a good one and full of life—and yet when a hill has been met which is steep enough to demand a lower gear, the power has fallen away in an extraordinary manner. Naturally, the first explanation which presents itself is either inefficient transmission or incorrect gear ratios. However, either of these is not always the correct explanation. In many cases the deficiency is simply due to shortness of petrol. It does not seem to be realised by many that an engine which is being "starved" of petrol does not commence to "pop" back into the carburetter unless the supply becomes so small that the mixture will not fire. There are intermediate stages between a full supply and one which is so much restricted that the car utterly fails to climb a hill for lack of fuel, and many a car which never pops back or misses on a hill is, nevertheless, not getting a sufficient supply of petrol to enable it to give off full power. This is often due to the tank being at too nearly the level of the float chamber on a gravity fed carburetter and to insufficient air or exhaust pressure in pressure fed systems. There are also such things as sluggish or binding

floats which rub on the needle valve stem or on the sides of the float chamber when it is out of the vertical, as it is when on a steep hill. A less common defect is one of design, when, as sometimes occurs, the float is placed some distance behind the jet, so that on a steep incline the jet is too much above the float chamber petrol level to feed properly.

THE IDEAL ARRANGEMENT.

It should be borne in mind that when a car is climbing on a low gear the engine is running fast and often at full throttle, so that the demand for petrol is greater than it is at any other time except when running at full speed on the level. On the level there is plenty of petrol because the car is not "tipped up" as it is on a steep incline. In many cars which have the tank under the front seat the tank outlet is only a little above the level of the carburetter float chamber, and it is obvious that as soon as the car is climbing a hill the float may be only getting a trickle of petrol instead of its full supply, so that when the demand is greatest the supply is least, and yet it may never be so little as to stop the engine altogether. At the same time it is quite apparent that if the engine be starved by this partial failure of the petrol supply loss of power is caused just when it is most required, and it is the secret of much bad climbing on the part of cars which do well up to a certain point and then die away most disappointingly when really severe collar work has to be faced. No hard and fast rule can be laid down, but if a man knows his car well both in mechanical detail and performance he can form a very good idea of how it should behave under different conditions. For instance, he knows, or should know, all the gear ratios, as well as the speed at which the car will run on the level, and if it will run fast, and accelerate with ease, and is full of life on the level but disappointing on steep hills, he may be convinced that this is probably due either to his gears being too high or to a restricted petrol feed.

With gravity fed carburetters the simplest way to experiment is to note the speed up some particular hill first with a full tank and then with a tank nearly empty. It is also easy to measure the distance from the float chamber to the petrol tank as well as the differences in level. Without going into the niceties of calculation, it will be obvious that if a tank be 2ft. from the float chamber and the "head" of the petrol in the tank 4in. higher than the float, a hill of 1 in 6 will practically stop the flow of petrol. Even in cases where the head of petrol is better than this we have found if the

tank be nearly empty there is undoubtedly some starvation, and quite the simplest cure is to solder up the air vent in the petrol filler plug and to fit a hand air pump. The pump should be placed at a convenient position by the side of the driver, and an occasional stroke will keep a slight pressure of air upon the petrol so that it will always flow readily into the float chamber.

In pressure fed systems there is not usually much doubt as to the condition of the system. The air pumps worked from the engine or gearshaft are now so common that many of the old troubles from exhaust pressure have been abolished, but even these air pumps occasionally get dirty and require cleansing or adjusting, or both, according to their construction. As a rule, any pressure over 2 lbs. to the square inch is unnecessary, and tends rather to waste. Where the pressure is maintained by exhaust the back pressure valve and filter should be cleansed periodically, as well as the bypass pipe from the exhaust, for all these are apt to get dirty, especially if the engine have an exhaust which is at all foul. Whether the pressure be by air pump from the engine or by exhaust there is, of course, always the hand pump to fall back on. The ideal arrangement, all things considered, is the dashboard tank, as this gives the simplicity of gravity feed with the advantages of pressure feed. That is to say, the tank is out of the way, and, at the same time, there is always a good head of petrol on the float.

Filler Cap Leakage.

232 On cars provided with either air or exhaust gas pressure for the lubricant and fuel systems, trouble is often encountered at the joints of the filler caps to the oil and petrol tanks. The makers as a rule fit either cork or fibre pressure pads inside the brass caps, which are compressed against the brass edges of the filler nozzle when the cap is screwed home. Leakage occurs at these points for three main reasons: That the original pads perish rather quickly, or the pads are too porous even when new, or that a milled-edge cap cannot be tightened sufficiently by hand, and a big pair of gas pliers is not always available, and when at hand is not good for the cap. Leather washers well rubbed with gear grease are far more satisfactory. The writer takes an old kid glove, inks the edges of his filler caps, presses the cap on the glove, and then cuts out the circle so marked. Two or three of these washers to fit each filler cap are carried in the door pockets of his car, and if at any time a washer becomes leaky he always has a spare ready to hand.

PETROL AND TANKS.

Engine Starved of Petrol.

233 On my new car I have experienced and traced the cause of a trouble which I imagine is somewhat unusual. The symptoms were that the engine was starved of petrol, resulting in loss of power and inability to run at any speed above 15 m.p.h., even on flat roads. By accident I discovered that the cushion of the driver's seat was bearing upon the vent hole in the filler cap of the petrol tank, causing a petrol lock, brought about by the partial vacuum set up in the tank owing to the absence of ingress of air when petrol was used. I have heard of the same trouble owing to there being no hole at all in the petrol tank cap, but on a new car the seat cushion should not have depressed to the extent referred to.—C. S. L.

Petrol Tins in Hot Weather.

234 A good many motorists are compelled to keep their cars and their petrol in sheds which become exceedingly hot in summer time. It is always well, therefore, to keep a careful eye on the petrol, as the heat causes a certain amount of expansion, and tins which would not leak at lower temperatures are apt to spring a leak when the weather is exceptionally hot. There is no particular harm in this except that one loses a small quantity of petrol, but it is well to take special care so that no matches are thrown about or any foolish risks of this kind taken. We know these things are done repeatedly and no evil results follow, but as petrol leakages are much more prevalent in hot weather than in cold, any carelessness is likely to be followed by serious consequences. It is a wise plan to look at one's stock of petrol every few days to see that none of the tins are leaking. Of course, any leaky tins, the seals of which have not been broken, can be returned to the retailer.

Carrying Spare Petrol.

235 A very useful plan for carrying spare petrol, which I have used myself for some time, but do not claim as original, is to take an ordinary two-gallon petrol can and make a cloth or carpet cover just to take the can with the end of the cover to button over, and this carried in the car makes a most convenient footstool, and if the contents are desired to be used at any time they are always handy to be put in the tank. This method has the advantage that no extra tanks or pipes, with their concomitant possibilities of stoppage and leakage, are necessary or desirable in this connection.—HARRY PARSONS.

A Cheap Petrol Gauge.

236 A very efficient and cheap form of petrol gauge can be fashioned from a sufficient length of ground-glass rod, which should be fairly stout. Run your car on to a level place, empty your tank, and then measure the spirit back therein gallon by gallon. After the introduction of each gallon sound the tank with the ground-glass rod, and the height of the spirit therein will be plainly visible on the rod. Mark the height of each successive gallon on the rod with the edge of a sharp file, and, the rod being kept in a leather clip handy to the tank, you will have a ready means of determining how much spirit there remains in your tank at any time.

Water in Petrol.

237 The symptoms of water in petrol are not too generally known, and there is nothing about them to identify the cause—they are simply misfiring, more or less chronic and more or less pronounced, according to the degree of the dilution. Most motorists afflicted by this trouble are probably duped, just as we were, and run through the whole gamut of tests. This trouble may afflict any motorist at any time, and since the only safe test for it is to empty the tank and refill with fresh spirit, if any is available, it is obviously a trouble to avoid. There is only one certain method of avoiding it, and that is, to carry one's own petrol funnel perpetually on the car, and to test the gauze of the funnel to make sure it is fine enough to retain water.

However, occasionally water is put into or finds its way into a petrol tank, and difficulty is then experienced in removing it. This particularly refers to gravity tanks, which do not usually have a sump to catch impurities in the petrol. A good plan to remove a small quantity of water from a tank is to take a wet chamois leather, wring it out thoroughly and make a pad of it at the end of a stick. If this pad be inserted in the filling orifice of the tank it will pick up any water with which it comes into contact. It will often be found that even if the tank be detached it is impossible thoroughly to clear it of water without some such aid as that suggested.

An Exhaust Pressure Feed Trouble.

238 For the first time we have had a temporarily incurable trouble with one of the very best exhaust pressure systems made. What happened was this. During two nights of a cold spell of weather the car had to be kept in an unwarmed coach house. Of course, the water was emptied out, and therefore on going to start the car no trouble

was anticipated. Pressure was worked up by the hand pump as usual, and the gauge showed that there was no leakage. For all that not a drip of petrol could be forced into the float chamber, although the tank was full. The air pump was used to the utmost, but despite the high pressure generated, no petrol came along the petrol pipe, and on opening the petrol tank we found that it was absolutely without any pressure. Even now we do not *know* the cause of this, but we can safely assume that moisture in the pressure pipe to the petrol tank had collected and frozen so as to stop it, pressure being maintained in the usual way by the exhaust (and there is always a certain amount of water in the exhaust gases). We should say here that the pressure valve itself was all right. As we were single-handed we could not lift the body to disconnect the pressure and petrol pipes, and we had to give the matter up temporarily as a bad job. A stove was introduced and in a few hours the air in the coach house was warm. We then had no difficulty in pumping pressure into the petrol tank. We mention this matter rather as a problem to be solved than a " hint and tip " in the usual acceptance of the term, but it does contain a couple of hints of a sort after all. The first is that if anyone should experience a similar difficulty to that which we suffered, the only remedy appears to be to warm up the house in which the motor is stored as soon as possible, as the trouble will then rectify itself. The second is that it would be advisable to fit a tap and screw nipple to the plug of the petrol tank, so that if the pressure pipe should become blocked through condensation of moisture within it or from any other cause it would be possible to pump pressure into the tank direct. There would be some objections to having a tap in the filling-in plug of the petrol tank, as it might be turned on by mischievously inclined people, so that the better way would be to have a little screw plug in the centre of the large plug and carry the tap among the spares, so that it could be screwed into the filler cap should the necessity arise. There appears to be no reason why it should not arise at any time an exhaust pressure fed car is left exposed to extreme cold, as even the provision of a good filter will not necessarily prevent some moisture from passing down the pressure pipe into the petrol tank, though one is always provided on properly installed exhaust pressure systems.

Protecting Pressure Feed Tanks.

239 A motorist brought a car to me recently and asked me to convert his pressure fed petrol supply into the

gravity system, stating that his pressure tank, set in the normal position low down under the back axle, possessed no false bottom, and was always being damaged by stones, so that on three separate occasions the car had been towed to a repair shop. Prabably 75% of the pressure feed tanks in use have no false bottom or other protection, and are subject to similar accidents when rough roads are being traversed, and small, sharp stones are flung about by the rear wheels. I resolved to save him the expense of so radical and inconvenient a conversion, and procured a sheet of perforated zinc of such dimensions that it snugly covered the tank, its facing edges running across the tank from end to end. I cut slots in it to permit the piping and filling stopper to emerge, and arranged these orifices in such positions that the ugly join came on the forward side of the tank, where it was absolutely invisible. I then got a saddler to rivet several thick straps of stout leather across the sheet of zinc, so that it stood out about $\frac{3}{4}$in. from the metal of the tank, padded out by the leather on its inner side. A couple of stout straps with buckles were then riveted to the outer side, by which it was fastened tightly around the original tank, and it was finally painted to match the colour of the car. The total cost was about 9s. The tank is now as reliable as the most expensive type with an internal false bottom, and is immediately detachable for occasional cleansing.—NORTHANTS.

Tank Pressure without a Pump.

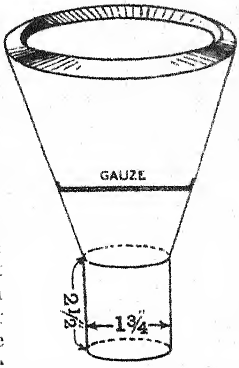
240 The engineer-in-charge of the garage attached to the White Lion Hotel, Cobham, Surrey, recently brought to our notice a tip which proved very useful at the time, and which may be so to some of our readers should occasion call for it.

Upon attempting to start the engine of our car when leaving the hotel after a meal we found that pressure in the petrol tank had fallen to zero, and that the pump on the dashboard was suffering from some small defect rendering it inoperative. We were proceeding to take the pump to pieces to set it in order when the engineer-in-charge demonstrated that a hand pump is not essential to obtain the necessary pressure. Whilst we, at his suggestion, turned the engine round a few times by means of the starting handle, he held his hand over the free end of the exhaust pipe at the back of the car. In this manner a pressure was set up in the exhaust branch pipe and silencer which had the effect of lifting the non-return valve in communication with the exhaust pipe

and raising the pressure in the petrol tank in a few seconds, far more quickly than would have been the case had the hand pump been used.

The pressure set up within the exhaust branch in the manner described was far in excess of the normal back pressure of the exhaust gases, some of which, in passing through the non-return valve, maintain the necessary pressure in the tank when the engine is running.

Petrol and Oil Strainers.

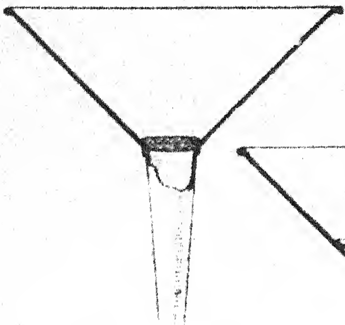


241 I have had my funnels made so that the lower part which carries off the petrol after it has passed through the gauze, *i.e.*, the tube portion, is much wider than the kind usually sold. It should be quite straight, and not tapering. I find that by making the diameter of the lower portion from 1½in. to 2in. the petrol can be poured into the tank in an incredibly short time. Although this appears to be a very small matter, yet I have found it very irksome to pour in petrol with the old style of strainer. It is usually these small things that annoy a motorist more than anything else when preparing for a tour. It should be noted that the gauze is not at the smallest diameter of the funnel, so that it is of much larger area than usual, and despite the fact that it is 120 meshes to the inch, the petrol " falls " through, but water will not pass it.—MARTIN E. SMUTS, Cape Town.

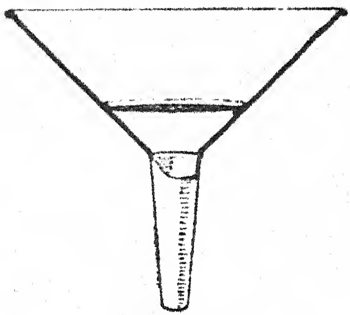
Area of Gauze Strainers.

242 The majority of strainers supplied to motorists, whether they be for filling petrol tanks, water tanks, or lubricating tanks, are made on an entirely wrong principle. It will be found that with most of them one can pour in the liquid much more quickly than it will run out, so that one has to stop pouring to avoid waste and mess. This is sometimes due to the smallness of the outlet, but it is very much more often because the gauze strainer is of such small area. We are not referring to the fineness of the gauze, as if the area of the strainer is large enough, one can pour in petrol through an extraordinarily fine mesh without the least accumulation of the liquid upon the top of the gauze. Of course, the water strainer and the oil strainer are much coarser, but if the gauze be of proper mesh for the fluid it is to strain,

nothing but the very thickest lubricating oil would ever cause trouble, and with a gauze of ample area, that will be disposed of in vastly less time than with a gauze of small area. To illustrate our meaning we give a couple of sketches of tundishes which are of exactly similar dimensions, but one with



A small and tiresome gauze.



A large gauze.

a mesh of larger area and the other with the usual small mesh, which is scarcely larger in area than half-a-crown. It is only fair to add that our attention was particularly drawn to this matter by the satisfactory working of the Rankin collapsable petrol strainer, which has a gauze of some 4in. diameter, and which, although exceptionally fine, carries away petrol as quickly as it falls upon it.

The Necessity for Fine Petrol Strainer Gauze.

243 A ninety-mesh gauze is of little or no use at all. It will not keep back water or fine dirt, which is its only duty. I have tested the point of the water, and find that this will pass a ninety sieve very easily, especially when all the petrol has run through. A 120 mesh, or even finer, should be fitted to all petrol fillers to make them of any use; in fact, the criterion of what is the coarsest gauze that will serve should be the capability of not passing any water. Petrol has such a low viscosity and other physical properties that it will pass fairly easily through even fine calico, and

the hint of putting a little extemporised funnel of this material over their present fillers may be useful to readers.

It seems, therefore, imperative from the results of these experiments to fit at least a 120 gauze instead of ninety in all petrol funnels, as well as carburetter filters.—J. E. STACEY JONES, B.Sc.

Caps for Spouts of Petrol Funnels.

244 Dirt may get into the tank without passing through the funnel at all, even if one is careful to clean the neighbourhood of the filler before removing the cap. The explanation is simple enough, although we do not remember ever having seen or even heard it referred to. We were just in the act of filling up on one occasion when we happened to notice some dirt in the spout of the funnel, and that solved the mystery at once. Too often the funnel is kept among a lot of more or less dirty tools and oddments, with the result that a quantity of foreign matter finds a hiding place within the spout of the funnel. It is washed out of its refuge by the petrol, and ultimately finds its way to the vital point, where it is emphatically matter out of place. Every funnel should be fitted with a cap for the spout, to keep the interior clean, and the cap should be secured to the dish by a chain. It seems extraordinary that the above defect of the ordinary funnel has not been realised before, but if it had been we feel certain that funnels with dust caps for the spouts would immediately have become standard.

Leaking Petrol Tank.

245 It is a good plan to carry a length of rubber piping which nicely fits on to the petrol pipe from the tank to the carburetter. If the tank should ever leak seriously that rubber pipe can be put on one end on to the petrol pipe. The other end, which has a short length of metal pipe, will be put through the cork of one of the two two-gallon tins of petrol which should be always carried in the car, irrespective of what may be in the running tank, and by propping or holding up this tin the driver will be able to get petrol to the carburetter, and reach home or a place where the tank or its connections can be made good. One is so absolutely helpless in a really serious petrol leakage that it is just as well to consider what is to be done in a case of this kind.

On Repairing Petrol Tanks.

246 Should a tank or other vessel which has contained petrol require repairs calling for a soldering iron great care should be taken to clear such tank of any petrol

fumes which may remain therein, otherwise there is the possibility of an explosion occurring. Petrol fumes, being heavier than air, will remain in any vessel for a considerable time, even though it has an opening to the air. There are several ways of clearing away such fumes, of which turning the tank with its opening to the lowest point and leaving it so for several hours is the easiest. Another method is to subject the tank to indirect heat in a similar position to that mentioned; this is, perhaps, the quickest method, though not always convenient. In any case, it is always advisable to keep it, if a blow lamp is used, as far away from the tank as possible.

Breakages of Petrol Pipes.

247 Some petrol and oil pipes have collars brazed on, as shown in fig. 1, but this method has two defects; Firstly, the pipe is softened and weakened by the heat required for brazing; and secondly the union nut holds it

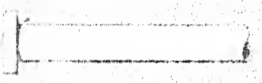


FIG. 1

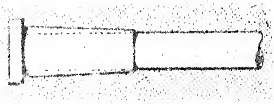


FIG. 2.

rigidly in a square corner, forming a "root," which should be the strongest and stiffest part, for all strains due to vibration are concentrated at this spot. A fracture is certain to occur sooner or later at the point indicated by the arrow. A vastly preferable type of joint is made by the use of a sleeve, such as shown in fig. 2. The length of this sleeve is such that

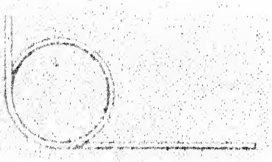


FIG. 3.

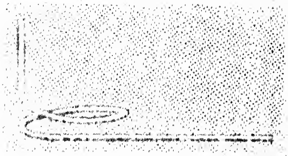
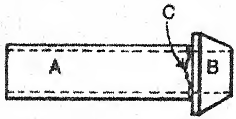


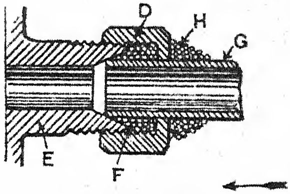
FIG. 4.

enough surface is in contact between the sleeve and pipe to make the use of soft soldering quite sufficient, thus eliminating the danger of weakening the pipe by the heat necessary when making a brazed joint. It is sometimes advisable to make a coil in a feed pipe if the pipe be a short one. The idea of this is, of course, to allow some spring which shall relieve the

joint of a certain amount of strain. Such a coil should not be made as shown in fig. 3, but horizontally, as shown in fig. 4. Where the length of pipe will allow of it, it is better still to make two coils, but in that case one of them may with advantage be as shown in fig. 3.—C. R. GARRARD.

We have had experience of various petrol pipe breakages on cars on test. In one case the petrol pipe had been "kinked," and subsequent vibration started a minute hole, which caused the petrol to spurt out. We applied a band of insulation tape, which completely stopped the leakage, and lasted for some time without any trouble whatever. The use of insulation tape for this purpose is very generally known, but this useful substance is not carried on cars to the extent it should be. It is one of the most handy things to have in the case of trouble with a petrol pipe.





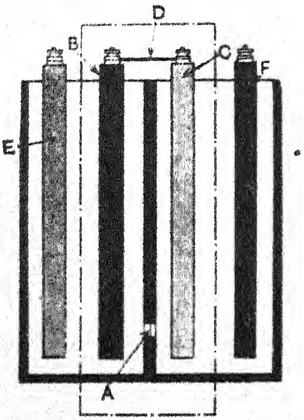
In another instance it was the petrol union that broke, "and we were far from home." The union generally takes the form of a short sleeve A with a conical end B, which is soldered or brazed on to the petrol pipe. In this case the union sleeve A broke off at C, leaving the cone in the carburetter connection. We had no facilities for repairing this on the spot, and very few tools, as the car was a trial one, and we were five miles from a town. We unscrewed the union portion D from the carburetter E and removed the cone B. We then obtained some string from a farmhouse and unravelled it, packing the union D after the manner of the gland of a stuffing box, as shown at F, the petrol pipe G resembling the rod which works in the stuffing box. The drawing will show clearly how this was done. The union D was then screwed upon the carburetter, taking care to keep the pipe in position, and a piece of string was tied to the petrol pipe, so as to pull it in the direction of the arrow and keep it in place. After this, string was wrapped round the pipe close to the union, as shown at H. This repair only permitted a little petrol to escape, and enabled us to reach a town, where a new union sleeve was fitted.

ACCUMULATORS.

Accumulator Leakage.—The Care of Accumulators.—Packing the Accumulator.—Protecting the Terminals.—Frothing of Accumulators.—Storing Accumulators.—A Useful Accumulator Box.—Battery Troubles.—Testing the Acid in Accumulators.—Electrolyte Evaporation.—Neutralising Spilt Acid from Batteries.—Cleaning the Terminals of Accumulators.—Stray Notes on Accumulators.

Accumulator Leakage.

248 Occasionally, an accumulator, especially one having a celluloid case, will spring a leak, and the acid be lost. This should not happen in the ordinary way, but we experienced a case a short time ago. A new battery box had been fitted, and the workman who had carried out the job left one of the screws projecting slightly above the bottom of the box. The combined effects of the weight of the accumulator and vibration caused the screw to puncture the accumulator close to the division between the two chambers. As the accumulator was not at the time coupled up, we had no notification of any trouble, but on arriving at our destination we saw the effect in the form of corrosion of the adjacent parts, and had to adopt the usual remedies for removing the corrosion.



A, point of damage.
B C, positive and negative plates coupled by D.
E, positive plate.
F. negative plate.

Inspection of the accumulator instantly showed the cause of the trouble, and a file soon prevented its recurrence. The screw had punctured, as stated, right at the division, as indicated at A, but the acid from only one chamber had escaped. As we were touring we did not wish to leave the battery to be repaired, so we proceeded to carry out the work ourselves. Some acetone was procured from a chemist,

and a photograph film cut up and dissolved in it. With this a paste was made to patch the hole up. Next a piece of celluloid was cut, and this stuck over the hole, and a second patch on top of the first. We obtained some acid, and mixing this in the proportion of one part of acid and four of water, we refilled the cell. Testing with the voltmeter, we found a satisfactory voltage, and thought that our troubles were at an end.

We thought that probably it had discharged itself owing to its unusual treatment, and decided to have it recharged on our return. On handing it over to the battery makers, they pointed out that the acid was at the same level in both cells, and that in all probability there was a leak in the partition, which accounted for the accumulator only developing half its voltage.

This proved to be the case, and probably what had happened was that the acetone used to fill the hole close to the partition had dissolved some of the partition or weakened it, causing the leak eventually to occur and the trouble above mentioned to ensue.

To many people it may seem curious that a leak between the two halves of the accumulator could cause fallen voltage. The explanation is quite simple, and should an accumulator only give about 2.2 volts, this cause should be looked to, and should be attended to at once, as if not attended to at once the accumulator, or, at any rate, two of the plates, will be spoilt.

We give an illustration showing the explanation of this, the hole A representing the leak. Directly the leak sets up, it practically forms the whole two-cell accumulator into one large cell, the action of the electrolyte being able to take place through the leak. As two of the plates B and C are connected together by the ordinary connection D, these two plates are short-circuited, just as would be the case if a wire were connected to the positive and negative terminals of the accumulator. These two plates discharge themselves, leaving the other two plates E and F to give the half voltage above mentioned. To make the explanation simpler, we have dotted in round the two short-circuited plates B and C a line to show diagrammatically how these two plates, to all intents and purposes, form a small short-circuited cell of their own. As the leak A is, generally speaking, very small, the resistance to action is very great, and consequently the battery can be charged without difficulty, but in course of time the charge will fail, as above mentioned.

The Care of Accumulators.

249 The accumulators are only too often the most neglected item in the motorist's outfit, which state of things is probably due to the high state of efficiency to which the magneto has been brought. Take, for example, a car fitted with both magneto and accumulator and coil ignition; the magneto is used exclusively except for starting purposes. This, of course, should not be so, for a properly kept accumulator, in conjunction with a good coil and distributer, should give equally good results as the best magneto.

A good accumulator should have plenty of acid space, and the plates should not be crowded up too near the case of the cell; this is a hint which might well be taken to heart by some makers who endeavour to crowd as many plates as possible into a small space, and this crowding applies particularly to cells with celluloid cases.

The cell as it reaches the user is not perfectly "made"; as a rule, it contains no electrolyte, and though the plates have been charged or "made" up to a certain point, it is left to the purchaser to complete the actual formation of the accumulator.

PURITY OF SOLUTION ESSENTIAL.

Owing to there being no acid solution in the cell, and also because of the action of the air on the plates, a new accumulator is always more or less sulphated. The maker gives definite and explicit instructions as to the filling of the cell with electrolyte, the amount and duration of the initial charge, along with other directions as to keeping the accumulator in proper working order; these instructions should on no account be ignored, and the motorist is well advised to look after the initial charge himself.

The cell should be filled to a point ¼in. to ½in. above the plates with distilled water and pure sulphuric acid of the stated specific gravity (the mixture being cold, of course). Purity of the electrolyte is absolutely essential from the fact that the charging and discharging of an accumulator is simply a chemical process—and a complicated one at that—and the first principle in chemical reaction of any description is absolute purity of the elements used in the reaction.

The cell must be put on charge for the specified time and rate, and though it is better to have the primary charge a continuous one, it is not absolutely necessary; for instance, if directed to charge for, say, ten hours at so many amperes, it would suffice to charge for two periods of five hours each, if it be found inconvenient to give the full charge continuously.

THE FIRST CHARGE THE MOST IMPORTANT.

It is imperative that on no account must the accumulator be used until this primary charge is quite complete, for this first charge "makes the plates," desulphates them, so to speak, and it is on this first charge that the ultimate life and capacity of the cell so much depends. Too much importance cannot be attached to the purity of the electrolyte; tap water often contains organic matter, salts of calcium, potassium, and sodium, while commercial sulphuric acid is not always entirely free from arsenic. Among other impurities sometimes found in accumulators may be mentioned copper, iron, ammonia, any one of which is quite sufficient to impair very seriously the efficiency of the cell.

In the process of charging and discharging, the plates expand and contract, the expansion being so pronounced at times as to cause the celluloid casing to bulge. Hence the necessity, when selecting a new cell, to see that the margins of the plates do not abut too closely on the casing.

After the first charge it is well to "go easy" in the matter of discharging the cell and after moderate use to charge again, and charge *fully*; nothing is more disastrous to a cell than to give it a small charge. Charge fully or not at all, *i.e.*, until vigorous gassing takes place.

THE LIFE OF ACCUMULATORS.

With regard to the life of an accumulator it is often stated that after two years a cell is useless; in many cases this is so, especially with neglected cells which are left to the tender mercies of some establishments where one can see six or more accumulators of varying capacities — from 10 amps. to 100 amps.—coupled up in series and being charged at the same time.

A well-tended cell should, with reasonable care, last five to seven years if used constantly and charged regularly. It is well to note that it is far better to keep accumulators in use—if not on the car, then for running the inspection, tail, or dash light—than to charge them, fill them up with water, and lay them aside. If, however, they must be put out of use it is important to keep them from the light, in a cool place, and to inspect them regularly in order that the water may not fall below the level of the plates, for with insufficient liquid sulphating will occur.

ACCUMULATOR TROUBLES.

Nine out of ten of the ailments which afflict accumulators may be traced to the electrolyte. The fluid must be kept

above the level of the plates, and should one not be certain whether a diminution in the amount of the electrolyte is due to evaporation or to spilling of the fluid, it is good practice to renew the acid solution altogether rather than run any risk of having the fluid either too strong or too weak in acid.

Frothing of a cell is rather a common complaint, especially in those of the celluloid-cased type; whether the celluloid has anything to do with the trouble is rather difficult to determine.

Celluloid at the best is not a particularly stable compound, from the fact that one of its principal constituents is camphor, which is extremely volatile, and it is significant that photographic film manufacturers insist on their films being used within a year of their manufacture—a warning that is not necessary when glass is used as a support for the sensitive medium

In most cases frothing has its origin in the use of impure water lime salts being deposited on the plates and interfering with the process of charging.

When a cell develops the habit of frothing it will be noticed that the trouble begins almost at the commencement of the charge, and that no amount of charging will bring the cell to its proper efficiency. The remedy is to discharge the accumulator completely, by means of a 4 c.p. lamp for instance, empty out the acid, and fill up the cell with tepid (not hot) distilled water, and allow it to stand for a time. Repeat this washing with pure water two or three times so as to dissolve out the salts from the plates, then fill up with fresh electrolyte and give a long charge *under* the stipulated rate.

To Remedy Sulphating.

Sulphating is another common ailment which has a bad effect on an accumulator. This condition is quite easily recognisable on account of the white incrustations which form; usually on the edges of the plates.

The only remedy for this is a very long charge, much under the ordinary charging rate. Water, distilled or otherwise, will not dissolve lead sulphate, and it has to be left to the molecular activity of the constituents of the cell while charging to loosen the sulphate from the plates so that it falls to the bottom of the accumulator.

The use of an alkaline solution has been recommended in order to decompose the incrustations of sulphate, and it may achieve this object temporarily, but ultimately the cell suffers from this treatment, for the alkali only adds an uncalled for chemical reaction to the already sickly plates.

INTERNAL SHORTING.

An accumulator after being in use for some time may suddenly develop a seemingly unaccountable desire to discharge, usually at the most inopportune time. On examining the plates it is not uncommon to find that a small piece of scale—from the positive plates, as a rule—has become wedged between a positive and negative plate, thus causing an internal short circuit. If possible, a wooden searcher should be passed between the plates and the obstruction removed (another hint to makers, and that is, to provide vent holes much larger than they do at present).

Buckling of the plates may occur, and as the cure of this condition is beyond the average motorist, it may be well to state a few conditions which may cause this evil. Buckling of the plates may be due to—(1) electrolyte too weak, (2) short circuits, (3) too high a temperature (60° to 70° F. is the proper working temperature for cells), (4) overcharging, (5) undercharging, (6) plates exposed to air, and (7) impurities in the solution due to hard water or bad chemicals.

VIBRATION TO BE AVOIDED.

Accumulators often suffer much owing to the method adopted for carrying them on the car. The accumulator box is usually placed on the footboard, and as a rule there is no provision made to avoid vibration, which is very harmful to the cell. The accumulator box should not only have a removable top, but should also be provided with a side which hinges outwards, thus giving clear access to the box for the purpose of cleaning, and the easy insertion and removal of the cells.

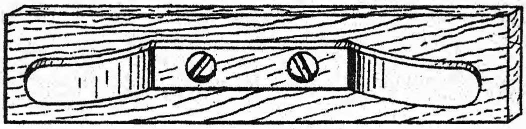
When the top alone opens the accumulator is, as a rule, held by the connecting bridge of the interior terminals and simply dumped into the box; whereas if the side of the box be hinged the accumulator can be laid into place and lifted out. The bottom of the box should be thickly padded with waste; old inner tubes can also be used for wedging, so as to avoid movement and vibration.

In conclusion, the well-kept accumulator gives yeoman service for the care bestowed upon it, and it is not, if properly looked after, the dirty accessory that some writers would have us believe.—PAGE.

Packing the Accumulator.

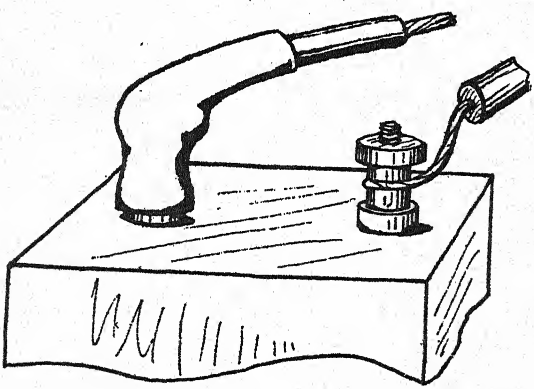
250 A fitting which will ensure accumulators from rattling in their case is that illustrated herewith. It consists simply of a strip of lath of some good hard wood, to which is

screwed or riveted the double-ended spring blade shown, made of a piece of spring steel. One or more of these wedged between the accumulator and the side of the box will keep all firm and prevent rattle and damage. The wooden part should be next to the accumulator, the spring pressing on the sides or top of the box.—F. H. B.



Protecting the Terminals.

251 A useful tip for those who wish to keep their accumulator terminals in good order is that illustrated. It has the effect of protecting the terminals and wires against corrosion, and also preventing danger through short circuiting. The end of the insulated wire is attached to the terminal in the usual way, but, as will be seen, the exposed length of wire is rather longer than usual. This is to allow it



to come up by the side of the terminal nut, so as to leave as little bulk as possible. Before the wire is attached to the terminal a piece of good quality rubber gas tubing is slipped up the wire. This tube should just fit outside the cable insulation, and if of good quality it can then be pulled down over the terminal as shown, thus protecting all the metal part.—F.H.B.

Frothing of Accumulators.

252 Prevention is better than cure, and to prevent decomposition of the celluloid case of an accumulator care must be taken that—

(1.) The cell must never be exposed to heat in any form, *e.g.*, it must not be left near a stove or fire, nor fixed on the car where any heat can reach it from the exhaust pipe; neither should it be exposed to strong sunlight. Also, if possible, it should be charged from a proper plant, and not through lamp resistance, as very often the cells, when charged in this latter way, are placed far too close to the lamps, and suffer from the heat which is radiated therefrom.

(2.) Care should be taken as regards the specific gravity of the electrolyte; if this be low it tends to increase the internal resistance of the cell, very often sufficiently to cause a high temperature to be produced when charging. This especially applies when, as is too often the case, an excessively high charging current is used. Generally speaking, a specific gravity higher than the correct figure is preferable to one lower.—F. BASS SUTTON.

Storing Accumulators.

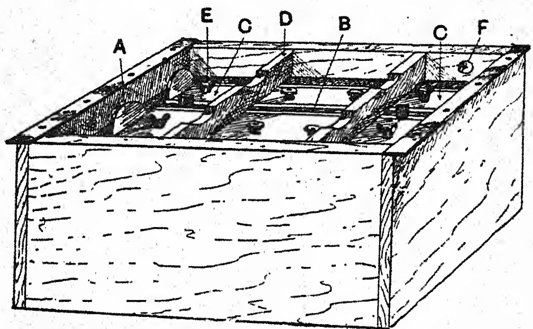
253 Although accumulators are not now used on cars to the extent which once obtained, there are sufficient in use at the present time to warrant a few notes on their storage when off the car. The following hints, which have been given to us by Messrs. C. A. Vandervell and Co., the well-known motor ignition specialists, are therefore worthy of consideration:

A new accumulator which has never been charged nor filled with acid may be safely stored if it be wrapped up kept in a dark, dry place. One which has been charged, and which it is desired to store without use for an indefinite period, should be coupled up to a lamp of the voltage of the complete accumulator and discharged until each 2-volt cell registers 1.9 volt. The acid should then be drained off to the last drop, and the accumulator stored as with a new and uncharged one mentioned above. The slight sulphate which may be formed when the cell is drying need not be the cause of worry, for it will disappear at the first charge at some subsequent period. If a charged accumulator is to be put by for any period up to six months, it should be charged to its utmost capacity, the terminals should be wiped perfectly dry and

greased, and the accumulator then stored in a dark, dry place free from dust. At the end of six months it will be found that very little of the charge will have been lost. Messrs. Vandervell recommend that under no circumstances, charged or discharged, should water be put into a storage battery.

A Useful Accumulator Box.

254 The carriage of accumulators used on motor cars is one of those things which appears to be quite a simple matter, but which in reality is rather difficult of satisfactory accomplishment. Accumulators are usually put into a box and packed with wood, waste, rag, or any material ready to hand.



Sketch of Mr. Worsley-Taylor's accumulator box.

A, lugs on interior battery boxes.
B, felt packing between C.
C, accumulators.
D, bridge pieces over C.
E, felt packing around C.
F, hole through which wires are passed.

Much of the trouble experienced in the use of accumulators is due to the fact that the accumulator jumps about in the box, and the vibration thus causes the paste in the plates to become detached and short-circuit the battery. The illustration we give shows the form of box which has been devised by Mr. J. Worsley-Taylor to remedy this defect. The idea was carried out for him by Mr. Farr, coachbuilder, of Blackburn. Mr. Worsley-Taylor informs us that he has used this box for nine months, and found it exceedingly satisfactory, as the accumulators are held perfectly secure against shaking, and the felt packing absorbs a good deal of vibration. The box is also very compact and neat in appearance. As will be seen by reference to the illustration, there is an outside box which is fitted with brass strips to serve the purpose of holding the lid in place when it is slid on to the brass strips. The

lid itself is furnished with a strip which hooks beneath the strip screwed to the box. Each accumulator is carried in a separate or inner box, so that it cannot be squeezed by the pressure of the packing. The outer box is lined with felt, and the inner boxes are slid into position. They are held securely by means of packing slips placed between the boxes, the strips being tightened by means of wedge pieces, whilst the boxes are also held down by the cross strips faced with rubber. When the box lid is slid on the whole is thus held securely. As the inner boxes are painted with acid-proof paint, there is nothing to deteriorate, and the box is quite water-tight. The wires from the accumulators are taken through a hole drilled in the side for that purpose.

Battery Troubles.

255 When an accumulator has been standing idle for any length of time, although it may show four volts, and even slightly over when tested by a voltmeter, it is not safe to assume that it will work in a reliable manner when desired for ignition purposes to run a motor. The voltage of an accumulator may appear to be fairly high after a rest, and yet immediately a small amount of current, such as is used by an induction coil, is required from it, the voltage drops down from below 3.8, and this is insufficient to work an ordinary ignition coil. The best way to keep accumulators which are not used regularly is to give them a freshening up about once a week or fortnight by connecting on to a charging dynamo. When treated in this manner very little charging current is required, and the batteries are always kept in excellent working condition, free from sulphating of the plates, and can always be relied upon for use when required. They should never be run below 3.8 volts, or the plates are liable to become damaged by buckling. Always test with a voltmeter.

Testing the Acid in Accumulators.

256 It is a good practice occasionally to test the specific gravity of the acid in one's accumulators by the aid of a hydrometer. This is a simple and inexpensive instrument, consisting of a weighted glass sealed tube, provided with an index. If when tested the acid shows a low specific gravity, a little more acid should be added to the cells until the hydrometer shows 1.190 on the index, level with the surface of the acid. A healthy cell, when discharged down to 1.75 volts, should have a gravity of about 1.185, which will rise to 1.205 on charge. If the gravity is low, say 1.150, it is an indication that the cell is over-discharged, has an internal short, or

other defect. Any shorts should, of course, be removed, and it is a good plan with such ignition cell to charge at about one-fifth the normal rate for three or four days. Spilt acid must be replaced by 1.200 acid, but evaporation should be made good with pure water. Too high a gravity means a short and expensive life. When it becomes necessary to add some acid to the cells, that known as *brimstone sulphuric* should be used. It is well to note that when making up new solution to replace that which has been in the cells for some time, distilled or clean rain water only should be used, and that the acid should be added to the water. In making up new solution, it should be done in a clean glass jar, and the acid added little by little to prevent overheating. The solution should only be tested when cool. The approximate proportions of acid to water are one to four.

Electrolyte Evaporation.

257 When the electrolyte, or liquid, in an accumulator cell falls below the level of the plates by reason of evaporation, fill up with a little clean soft water, distilled if possible. Further additions of sulphuric acid are not required. Never allow the solution to get beyond ¼in. below the top of the plates; it may cause them to buckle. If for any purpose the acid solution is emptied from the cells, fill them up with water to prevent the plates sulphating.

Neutralising Spilt Acid from Batteries.

258 If any spilling of acid from the accumulators takes place, it is advisable to stop it immediately. The procedure varies considerably with different accumulators. If it is impossible to stop it at once, the action of the acid will set up corrosion and spoil the adjacent fittings, if it does no worse. A remedy is to cover the bottom of the battery boxes about 1in. deep with bicarbonate of soda. This is an alkali, and neutralises the acid. Being a clean white powder, it can be left in the box and does no harm, and is ready for each spot of acid that splashes out. This substance is a simple and cheap one, and work can be done on the spot immediately the bicarbonate has been applied, which is not the case with ammonia, owing to the strong fumes given off. The bicarbonate is supplied by any chemist, and quite a lot can be bought for 4d.

Cleaning the Terminals of Accumulators.

259 The terminals of accumulators often give trouble through the formation of copper salts or verdigris, particularly on the positive terminal. A very effective way

of cleaning them is by using a strong solution of carbonate of soda, or common washing soda powdered. This, being a strong alkali, will neutralise the acid on the terminal, and after washing in clean water and drying, it can have a slight coating of vaseline.—WM. JAMES.

Stray Notes on Accumulators.

260 Celluloid cases are not so good as ebonite for accumulators; the only advantage of celluloid is that the plates can be examined to ascertain if any of the paste is loosened or the plates deformed. Also any stray pieces of paste which may shake out and be liable to cause "short circuiting" can be located and easily removed without injuring the cells. When an accumulator is first put into use, it is best to take off the terminal nuts and then wax or vaseline the screw thread, and put back the nuts. On connecting up the wires, see that a clean connection is obtained between the terminal face and the wire contact. The reason for this is that any acid liquid or vapour may corrode the brass thread and nut, and so prevent easy removal when a fresh-charged battery is required. Whenever a terminal screw is found sulphated fast to an accumulator terminal so that it cannot readily be unscrewed with the fingers, never use the cold pliers and try to unscrew by exerting extra force. Make the pliers fairly hot, and grip the screw with them for some little time till it and the terminal are heated through. The screw will then turn and come away quite easily. If the terminal and screws are well smeared with vaseline before being screwed up there will be little trouble from sulphating.

ACCESSORIES.

HOOTER TROUBLES.—REPAIRING HORN BULBS.—LOOKING REARWARD.—TO CARRY SPARE COATS.—TYRE PUMPS.

Hooter Troubles.

261 An accessory with which the novice soon becomes acquainted is the horn, and it is favoured with more constant attention than any other of the car's furnishings. A perfect horn should deserve the motto of the Scots Guards —*Semper paratus*—for one never knows what may issue from the next turning or cross roads. The reeds which actuate the majority of the horns in use are (more or less) musical instruments, which require careful tuning by experienced hands. It often occurs that a horn that fails is handed to a man, thoroughly trained perhaps in engineering, but without knowledge of the method of handling this work, and in most cases he first attacks the vibrating tongue. The man of experience, on the other hand, would probably turn his attention to the reed proper, *i.e.*, the shell, against which the tongue beats, as it is usually not only better, but also easier, to effect the needed alteration in this way.

Sometimes a little dust between the reed and tongue will entirely spoil the tone, and many reeds are ruined by rough handling with the view of removing this "matter in the wrong place." A sheet of thin paper drawn down the back of the tongue will usually do the work, without fear of any injury to tongue or reed.

The quality of tone is chiefly determined by the size and proportions of the body of the horn, but yet the repairer is often requested to "fit a good deep reed" to a small horn, which is like asking for a reed of bassoon tone for a clarionet.

Another fact, apparently not widely known, is that the length of the horn extension sometimes affects the tone considerably, counter vibrations being set up in the flexible tube which considerably weaken the issuing tone. Experience shows that the horns of very deep tone are not so durable as those somewhat higher in pitch, the apparent cause being that the slow, but wide, vibrations cause "fatigue" of the metal tongues, and reduce the erstwhile diapason to a guttural croak with little carrying power.

Accidents cause bruises (we almost wrote "dents") and for their removal the repairer should be armed with mandrels

of various shapes to suit the varied curves, the procedure being fairly obvious.

Small bruises beyond the first bend can sometimes be dealt with from the outside. With a light, clean hammer, tap gently round the bruise, and the centre will be seen to rise gradually. Do not hurry, for if the process is slow, it is quicker than taking the horn to pieces and refitting, and with care a good surface may be obtained. Some repairers resort to the expedient of soldering a piece of wire to the centre of the hollow, and thus pulling out the bruise, afterwards removing the wire and solder, but this is not always applicable.

The indiarubber bulbs commonly used are not an ideal means of obtaining the wind supply, but as yet none of the forms of air pump which have been tried have proved as good, and we must depend on the careful selection of bulbs of suitable consistence, neither so thick as to tire the hand, nor so thin as to fail to regain their fulness when released.

Breaks in the flexible tube are due to want of support, and it is not the slightest use to mend the break without adding proper support. When sufficiently supported, the flexible may be rendered air-tight temporarily by wrapping it in thin rubber sheeting taken from the repair outfit, and binding tightly with thread for an inch on each side of the break, after which a piece of canvas should be wrapped over the rubber and tightly bound down. The first opportunity should then be taken to shorten the flexible tube, and to solder the union piece on to the cut end.

Repairing Horn Bulbs.

262 After reading some remarks *re* bulb of horn, perhaps I may be allowed to add that I have found the neck part has worn first, and that by far the best mending seems to have been the 1/- roll of black self-sticking insulating tape. Three or four times round, and, if necessary, graduating slightly upwards (quarter breadth at a time), makes an absolutely permanent and very air-tight renewal. As a matter of fact, the bulb is then very much stronger, more upright, and rigid than before. Both being black, the tape is not noticed, especially if a little Seccotine is put on each wind, and finally rubbed over all.—VILLIERS LUCAS.

Looking Rearward.

263 The looking glasses which many cars now carry so that the driver can see what is coming up behind him, how much dust he is making, and so on, are really useful things, and having once used them we would not willingly

be without some device of the kind, which, we believe, like a good many other practical ideas, was first introduced to the motor world by Mr. A. J. Wilson. There is one objection to these glasses, however, which can easily be overcome, and for the benefit of those who may be using them for the first time, we think it advisable to mention it. When driving at night, if a fast motor bicycle or a powerful car overtakes one, one is apt to be dazzled by the reflection of the acetylene lamps on the overtaking vehicle, and one may draw in to let it pass, without seeing, perhaps, that there are some bicycles comparatively close ahead. Of course, the remedy is a simple one. When one stops to light up, one should turn the glass down, if it is adjustable, or at any rate turn it away so that it will not reflect lights behind the car into one's eyes. If the adjustments are good there is no difficulty about this, and the old adjustment can always be obtained again in a moment if the telescopic or other joint is marked in the way that one marks a telescope so that one can get one's correct focus at once.

On fixed glasses the best plan is to buy one of the waterproof covers sold by chemists. We believe these are made for ladies who wish to bathe without wetting their hair. However this may be, they are most useful for covering a fixed looking glass, and it should be remembered that the better the glass, the more likely is it to dazzle the driver at night in the way we have mentioned.

To Carry Spare Coats.

264 When motoring, it is often a great convenience to carry a light rainproof coat or some other odd wrap for use when off the motor car, as a motor coat is too heavy for wearing then except in the bitterest weather. The worst of it is that carrying spare coats on a car is, to say the least of it, bad for the coats, as they kick about in the bottom of the car, and are more or less used as mats. We have found quite the best plan for taking a few odd items of this sort is to carry them in a large bag, practically the same sort of bag as one would take to carry soiled linen when away from home. Two or three coats neatly rolled up can be put in a bag of this kind, and it can be tucked away in some corner of the car without the garments suffering to any serious extent. A bag of this sort, by the way, is also the best thing in which a suit of overalls can be carried. It is true one need not be over-particular about one's overalls, but it is well to remember that if they are allowed to get too dirty they do not serve the purpose of protecting one's clothes.

ACCESSORIES.

Tyre Pumps.

265 Pumps usually require only the occasional fitting of a new leather cup. This is easy, even for a novice, if he will only exercise a little care to avoid cutting the edge of the cup when replacing the plunger in the tube. The plunger is usually fitted with a nut and washer, by the removal of which the old leather is released, when the new one is readily inserted. The cups are not worth making, as they can be bought so cheaply, but they should be well soaked in lard oil before using.

Pressure gauges as used on motor pumps have a hard time, as they are subjected to conditions which would not be tolerated for any other type of gauge. At every stroke of the pump the gauge usually flies to its highest limit, returning as suddenly to the existing tyre pressure. This action would destroy the gauge of a locomotive, and is bound, sooner or later, to weaken the Bourdon tube and cause the gauge, although correct when new, to "lie like a gas meter," by indicating, perhaps, 20 lbs. per square inch more than it should. It is necessary, therefore, that the gauge should be calibrated occasionally, taking care that it is compared with a really reliable standard gauge. Many tyres must have been condemned as having worn badly when constantly pumped up to 90 lbs. pressure by the user's computation, when the real pressure has possibly been anything from 80 lbs. down to 70 lbs.

LAMPS.

Care of Acetylene Lamps.—How Best to Clean Acetylene Generators.— Enclosed Generator Boxes.— The Freezing of Generators.—Drip Feed Generators.—Acetylene Lamp Tubing.—Tail Lamps Going Out.—Back Lamp Covers.—Cracking of Lamp Glasses.—Carrying Back Lamps.—Mangin Mirror Lamps and their Burners.—Broken Lamp Glasses.—Electric Lamps.—Cleaning Brass Lamps.—An Oil Lamp Tip.—Extinguishing Oil Lamps.—Repair of Acetylene Lamps.—A Good Method of Fixing a Lamp Bracket.—White Lead and Gas Burners.—Corrosion of Brass Accessories.

Care of Acetylene Lamps.

266 Many motorists have difficulty in keeping their acetylene lamps in good going order. The trouble usually lies in the lamp not being kept properly cleaned or through being improperly charged. To keep the lamp at its best light-giving powers, and to give the least trouble, clean water should be put into the tank every time the charge is renewed, and not merely fresh water added to that already contained in the tank. Fresh carbide should be put into the generator, and should there be any remains of the previous charge, this should be removed and carefully cleaned of all the free lime which may have accumulated around it. The deposit left by the dissolution of the carbide should be thoroughly cleaned out, the generator being washed and dried before the new carbide is put in. The burner should be kept perfectly clean, which can be very easily done by dipping it in liquor potassæ, and then washing it in alcohol or petrol. The small holes are best kept free by using the wire prickers which are usually supplied with the lamps, and then by clearing out any of the carbon deposit by attaching it to the tube of a bicycle tyre inflator and well blowing through it.

If in probing the tiny holes in an acetylene burner with the fine steel probes supplied by many makers one unfortunately breaks a piece off in the hole in such a way that it cannot be withdrawn or shaken out, it does not follow necessarily that the burner is ruined. Try expulsion with the tyre pump; but if this does not avail, it is possible to get rid of the stricture-forming fragment by putting the

burner into a solution of hydrochloric acid—a teaspoonful of acid to a claret glassful of water. The solution should be warmed while the burner is immersed therein, when the steel will be attacked by the acid and practically dissolved. Keep the burner in the solution for at least an hour; then rinse it well in water to which a pinch of ordinary washing soda has been added. This will neutralise the acid which may have penetrated the pores of the steatite.

How Best to Clean Acetylene Generators.

267 Unless the generator is kept scrupulously clean acetylene lamps are sure to give trouble. It does not matter, provided the container is air and gas-tight, how long the carbide remains therein, provided it is not used. But if the lamp has been used on at least two occasions (and few will light more than twice on one charge), the generator should be cleaned out. Unless this is done the dust will clog the gas outlet, and perhaps the water valve as well, and, worst of all, the carbide residue will eat through the brass of the container. On dismounting the generator, turn the residue into an old sieve, so saving the unused carbide, and having gently knocked away from the container all the residue possible, plunge the detachable parts of the generator, including the container, into a bucket of water. They may be left for half an hour, when, if attacked with a stiff brush, the deposit may be easily removed.

Enclosed Generator Boxes.

268 How is it that one sees nowadays so many cars with the acetylene generators exposed to the climatic conditions, for it is such a simple matter to have a small wooden box fixed to one of the running boards or in any suitable position? When travelling in cold and frosty weather there is much less likelihood of the water in the generator freezing if the generator itself is enclosed than if it is directly exposed to the cold air. The box should be large enough to enable the generator to be packed with cloths, so as to prevent any tendency to rattle and dispel all chances of the water freezing. Besides, a car presents a much neater and finished appearance with the generator stowed away in a box finished to match the car. Of course, these remarks do not apply to those cases where the makers forbid boxing the generator.

The Freezing of Generators.

269 There is one particular advantage of the separate generator for acetylene head lamps which the writer

does not remember ever having seen mentioned in print previously, but as he has had several self-contained head lamps spoilt by freezing in winter, he is keenly conscious of the point. The head lamp is in one of the coldest positions on the entire car, and if water be carried in it, the reservoir is exceedingly likely to be split by frost in winter work. The separate generator is infinitely preferable if the car be used regularly in winter, and may be safeguarded from freezing in the day time either by being removed from its working position altogether or by being jacketed. One owner of my acquaintance fits his loose generators in a well on the step, securing them by a little spring yoke of his own design. When the car comes in, the generators are removed and stored in the house; when the car goes out, the generators are laid in the bottom of the rear body until lighting-up time comes. Another owner provides his spare generators with felt covers during the winter; they will not then freeze unless the car be left in a cold stable for a long period. Yet a third owner carries his generator inside the frame in a well-lined box bolted to one of the side members, where they cannot freeze in any weather, but with this plan care must be taken to keep them at a safe distance from any part of the petrol system, or any item of the ignition which could conceivably create sparking. In all cases the generators of a car which is often used in winter should, in the writer's opinion, be separate from the head lamps, and should be easily detachable. It is bad practice to have the water reservoir rigidly secured by several bolts to the step—a prevalent custom.—B. H. D.

Drip Feed Generators.

270 There are still a good many generators on the market worked by an adjustable water drip, and under the influence of vibration the threaded rod adjusting the speed of the water drip is rather apt to work down and curtail the supply. This tendency is easily prevented by slipping a small spring between the rod and the top of the generator. This simple expedient has converted a very exasperating generator belonging to the writer into a very satisfactory affair, for the drip feed rod now remains where it may be set.—B. H. D.

Acetylene Lamp Tubing.

271 Several replies were received to the question propounded under the above heading in *The Autocar* of January 27th, 1906. The correspondents were all agreed that whilst there is the possibility of an explosion in the gas pipes,

it is very remote; however, there is a chemical action on all metals which come in contact with damp acetylene gas, hence it is not advisable to use more metal connections than are absolutely necessary. Steel tubing is least affected by the gas, and it has been suggested that by enamelling internally any danger might be overcome, and the piping preserved at the same time. Strong rubber tubing is recommended as being the best method of conveying the gas from the generator to the burner, though one writer advocates the use of ⅛in. gas piping or flexible steel tubing. That there is some danger in the use of copper piping is borne out by the fact that the Local Government Board prohibits its use in theatres and public buildings, as is the practice in America and on the Continent. The following incident also gives colour to this theory: A correspondent related some time ago how the copper lamp tubes of a car were quite choked up with a hard black substance like coal. Upon taking them down and applying a blow-lamp in order to try and melt the substance out, as it was very hard and refractory, small pellets of it flew out to a distance of quite 12ft. to 14ft., accompanied by little explosions or pops. This substance had accumulated in the pipe to such an extent that a needle could not be inserted in the end of the pipe, in spite of the fact that it was quite ⅛in. bore.

Tail Lamps Going Out.

272 On several occasions we have met cars stopped at night for no other reason than that the tail lamp kept going out. Observation has led us to believe that many a sound tail lamp is condemned by owners simply because the flame is habitually turned up too high. The owner further knows that the wick is gradually consumed, and makes allowance for its diminution by turning it up too high at starting; he further imagines a lofty flame is less likely to blow out. No lamps are so made that they will not smoke, and the consequence of turning these lamps up too high is that the lamp body soon becomes full of foul gases, which act upon the flame exactly in the fashion of an ordinary candle extinguisher. Our advice, therefore, is never to condemn or scrap a tail lamp until a very low flame has been experimented with. One lamp we purchased choked with smoke if turned up, and blew out if left burning low; but the enlargement of the air holes at the base permitted the wick to be turned up without smoking, and this higher flame was too sturdy to be blown out, so that the lamp was afterwards perfectly satisfactory.

Back Lamp Covers.

273 It is a good plan to have a hood for the back lamp, because this is the very dustiest place on the car; and after a long day's ride on dusty roads, it is often found impossible to get the lamp to burn, because it is so hopelessly choked up with dust. If one comes to think of it, it is ridiculous to expose the back lamp to so much dust and dirt. It is usually only wanted for a very short distance, a very small proportion of the total distance covered by the car, but when it is wanted, it is wanted badly, and it is only commonsense to take suitable precautions to keep it in good trim for use. We believe that nearly all the complaints about unreliable back lamps are due to the fact that these lamps are so hopelessly dirty in the majority of cases. We must say that we have never found any trouble with a good paraffin back light, so long as the most ordinary precautions in trimming are taken; but if the lamp be left continually in the dust and the oil is allowed to become as thick as treacle, and the wick so saturated with dirt that it cannot absorb oil, it is scarcely remarkable that this much-abused fitting should occasionally go out.

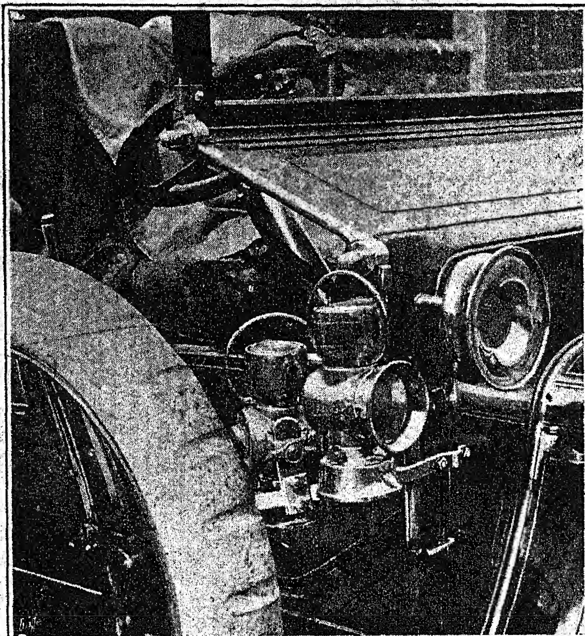
Cracking of Lamp Glasses.

274 When obtaining an acetylene head light or paraffin side lights for use on motor cars, the buyer should always see that the front lens can be renewed readily in case of breakage. When the lens or a plain glass front is fitted in solidly, the heat from the burner so acts on the lamp body and the glass that if the latter is not spring-fitted the chances are that it will crack; also the vibration may in any case crack it. The glass can be immediately renewed without returning the whole lamp to the manufacturer if a split spring ring is fitted to hold it in place; the ring also allows of any expansion due to heat. On many occasions when a glass has been found cracked the excuse has been given that the glass has been knocked by some hard substance, whereas in the majority of cases the failure has been due to the causes given above.

Carrying Back Lamps.

275 The practice of carrying the rear lamp on its bracket when not required for illuminating purposes is one which is not to be recommended when means can conveniently be arranged for carrying the lamp in a position where it will be kept clean and in good order for use when wanted. The illustration which we give shows how we have

arranged to carry the back lamp on one of our cars. There is a steadying arm to the ring carrying the Stepney spare wheel, which provides a convenient place whereon to fix a simple bracket to accommodate the lamp during the hours of daylight. Here it is out of reach of dust and dirt and



A bracket for a spare lamp.

damage. It is always in good order, can be readily lighted, and then removed to its bracket when the shades of night have fallen—a much quicker and cleaner proceeding than having to handle a dust or dirt-covered lamp cleaning the glass, and getting it to light, as is the case when the lamp is carried all the time on its working bracket.

Mangin Mirror Lamps and their Burners.

276 When one has disbursed a large sum for new head lamps provided with genuine Mangin mirror lenses of large diameter, it is very annoying to dismount and find

both lenses cracked right through to their base. This is likely to occur if the lamps be fitted with burners which create a flat flame by the impingement of two jets of gas at right angles in the plane of the car's direction of travel, and actually befell the writer recently. It was partly his own fault, as the light had commenced to grow pallid, but as his destination was near he drove on stubbornly instead of stopping the car to investigate. On dismounting, the rear jet of each burner was found to be choked from some mysterious reason, in spite of a new filter figuring in the gas circuit, and the front jet was directing a spear of flame right on to each mirror, with the inevitable result. It is better to use a flat jet burner, such as the Lucas, or failing that, Bray's latest, the Roni, which cannot under any circumstances damage the reflector, and is also very economical of gas.—B.H.D.

Broken Lamp Glasses.

277 In the event of the glass of the tail lamp being broken, it is useful to know of two expedients by which immediate progress is rendered possible. The first is to procure a sheet of thin red tissue paper at a stationer's or toy dealer's, and to tie it over the frame which holds the glass. As there is no head draught against the tail lamp, this dodge is perfectly practicable if the necessary reddish paper is procurable. A second method, which applies to any lamp on the car, is to get a sheet of "butter paper," which is obtainable at every village chandler's, double it, grease it, and lash it over the lamp front with wire. This is sufficiently transparent to allow of legal limit travelling with a single acetylene head light so shrouded, and at this pace a double layer of the paper is windproof for twenty miles at any rate. We have never been forced to apply this tip to a tail lamp, but if we were we should spill a penny bottle of red ink over the paper before greasing it, and trust that the police would be kind.

Electric Lamps.

278 Electric lamps have lately come into considerable popularity, but some trouble has been experienced with the filaments breaking, particularly when these are of osmium. We know, however, of one case in which an osmium bulb has travelled over 4,000 miles on a motor bicycle without the filaments breaking, as a result of the following tip, which was given us by an authority on the subject, and it generally results in a long life of the filaments, which otherwise would probably break in the first few miles, if subjected to excessive

vibration. The treatment consists simply in keeping the lamp alight for at least half an hour before it is taken on the road or subjected to vibration. This hardens the filament, and it will be found that if it travels the first hundred miles without breaking, its life will be quite long.

Cleaning Brass Lamps.

279 The following plan is a good method of cleaning brass lamps without much labour. It has proved very efficacious even when they were green with verdigris and in a shocking condition: Make a mixture of Globe brass polish and methylated spirit until it forms a paste of the consistency of cream, when it can be applied with a paint brush. The lamps should be left for two or three days, and the paste cleaned off with an oily rag. The paste, verdigris, and dulness come away without any rubbing, leaving the clean brass exposed, which requires merely the usual brisk polishing to restore it to its former brilliance.

An Oil Lamp Tip.

280 While it is common knowledge that acetylene lamps must be kept scrupulously clean, motorists often imagine that an oil lamp ought to run a whole year without an internal clean. One of the commonest reasons for oil lamps going out is the choking of the draught holes in the cap of the lamp by heavy deposits of carbon. These should be looked for and removed before any lengthy drive by night. The other essentials are a good lamp, good oil, and a clean wick, which should be dried in an oven before putting into the lamp.

Extinguishing Oil Lamps.

281 The average motorist extinguishes his oil lamps by turning down the wick, in order to save the clips of the lamp door from becoming slack by frequent usage. He leaves the wick turned down till the lamp is next required, and then forgets which way to revolve the button, with the result that ever and anon he turns the wick right down into the oil reservoir, and has sooner or later to fish for it in the dark with a bent pin. Moral: If you extinguish your lamps by turning down the wick, turn it up again before you quit hold, so that you may never forget which way to revolve the button. Of course, the best way to extinguish the lamp is to open the door and blow out the light, as that leaves the wick right for the next time of lighting.

Repair of Acetylene Lamps.

282 Of all kinds of accessories, the lamps provide the largest number of patients for the accessories hospital, and their ailments can easily be divided into two classes—(*a*) breakages and (*b*) faults in burning.

The former class is larger than many motorists would imagine, for if the lamps are to be well placed for illumination, they will also be in such a position as readily to come into contact with any obstacle.

Curiously enough, this class includes many lamps which have never been used, as many persons carry lamps to complete the *tout ensemble* of the car, rather than for actual night work. Again, novices often—and experienced drivers sometimes—misjudge distances, to the great detriment of the lampwork, which cannot be expected to withstand the impact of the several hundredweights of the car, even though it be moving but slowly.

It is rumoured that the head lights of a certain military man underwent no less than three "thorough repairs" before even being lit, the apparent result, in each case, of a miscalculated distance. One can only hope that our artillery will never have to rely upon his judgment as to range.

In the case of acetylene lamp smashes, whether such as described or those occurring in collisions, not only is the appearance of the lamp spoiled, but its internal economy is often disturbed, so that no repair should be considered complete until every gas tube and joint has been carefully tested for leakage. The explosion which follows a leakage is rarely dangerous, but often alarming, as the report is sometimes very sharp.

The damage usually most conspicuous is the inevitable bruising of the outer shell of the lamp, and some ingenuity is required in selecting or adapting tools to use as anvils or "stakes" for the smoothing-out process. If the shock has been heavy, the metal "buckles," producing folds so close that time and care must be expended to prevent cracking the metal, which would seriously weaken the structure, and also spoil its appearance. Small bruises may be dealt with in the way suggested for dealing with horns. Where the lamps have been well designed, so that the parts are interchangeable, it is often better to procure new parts from the maker.

As in the case of engines, the cost of the actual repair is frequently much less than the expense of taking the lamp to pieces, and reassembling the parts when the repair has been effected. This necessary expenditure of time sometimes makes repair charges look excessive, and the buyer of new

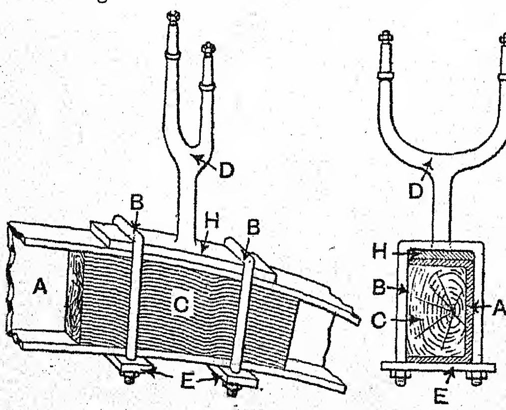
lamps will do well to ascertain if those offered him are designed with a view to the ready replacement of any damaged portions. The expensive factor of the lamp is not the metal, glass, etc., of which it is composed, but the time of the artisans who construct it.

A bad smash often injures not only the body of the lamp, but also the generator, and as some of these are much more complicated than is needful, the repairer should make sure, before dismounting them, that he is clear as to the position and purpose of each part. Every repairman could —" an he would "—tell of wrecks of lamps which had been overhauled by those who had not used this precaution.

Faults in burning in acetylene lamps arise from many causes. Faulty ventilation is not common, for the acetylene flame is so strong, and, if one may be allowed the expression, so stiff, that it will bear air currents which would extinguish any other flame. For this reason the ventilation usually errs on the side of supplying more air than is really needed, nor does this call for any alteration. Insufficient air supply is shown by a red flame, and may be corrected by piercing extra holes, or enlarging those already existing, taking care that no air current plays directly on the flame.

A Good Method of Fixing a Lamp Bracket.

283 In nine cases out of ten brackets to support heavy head lights are bolted to the frame members, which



A good method of fixing a head lamp bracket.
A, dumb-iron end of frame.
B, mild steel clips.
C, shaped hard wood filler, which is a tight fit.
D, lamp forks.
E, washer plates.
H, fork plate.

have to be drilled with three or more holes for the purpose. Even if these orifices are pierced in the neutral axis of the member it is bad enough, but time again we have seen holes drilled out of the centre of the web, and even in the flanges of the side member. Body builders who fit lamp brackets are generally found to be the guilty people in this matter, and a French correspondent of *Omnia* suggests that owners should insist that such brackets should be attached and secured as shown in the accompanying sketch. This method has much to recommend it, for it strengthens rather than weakens the frame at the point where the lamps are carried; also it allows the brackets to be given any desired position without bending the forks, and alterations can be made with nothing more than a spanner. The steel clips should not be less thau ¼in. in diameter.

White Lead and Gas Burners.

284 Not every burner will make a gas-tight fit on the threaded pipe of a head lamp without the aid of plumber's lead, and at times the spare burners are useless unless lead be available, for the gas leaks down through the thread, and catches fire round the foot of the burner. Soap is a tolerably satisfactory substitute for red or white lead in emergencies. Some motorists spoil the job by being too free with the lead when it is used. Recently we were grievously afflicted by the erratic behaviour of the lamps, which varied from a blaze of light to an apologetic flicker every two or three minutes. The whole trouble turned out to be due to too liberal an application of white lead to a pair of new burners. The packing had been smeared so thickly on the thread that great curls of it were squeezed up and dropped into the gaspipe below, successfully throttling down the supply until sufficient pressure momentarily accumulated and tipped them aside. A thin smear laid over the lower threads is enough.—B. H. D.

Corrosion of Brass Accessories.

285 Not every motorist is aware that brass corrodes rapidly in a damp atmosphere; the knowledge that its colour " wears the same all through " occasionally deludes an unwary owner into careless storage, with the idea that a little elbow grease will soon restore the pristine brilliance. The writer was foolish enough to lay by a costly pair of electric side lamps on a shelf in an unwarmed garage, and upon unearthing them some three months later they fell to pieces like eggshells. If they had been coated with paraffin, Rangoon jelly, or vaseline, the trouble would have been obviated.

TOOLS AND SPARE PARTS.

To the Novice.—Using the Spanner.—Box Spanners and Sparking Plugs.—Tightening Nuts.—Paraffin plus Patience.—The Hammer.—Removing a Bolt.—Straightening a Rod.—Riveting.—The Chisel.—Files.—The Usefulness of Tin Snips.—Pliers.—Lifting Jacks: Their Choice and Use.—Jack too Long.—How to Carry Tools and Spare Parts.—A Simple Tool Carrier.—To Start a Stiff Screw.—How to Make Shift with a Spanner a Size or two too Large.—Repairs and Spare Parts.

To the Novice.

286 To the skilled mechanic it is very often painful to witness the manner in which the novice handles his tools when effecting repairs. Like everything else, there is a right and a wrong way of using the various implements which are required in repairing or overhauling a motor vehicle.

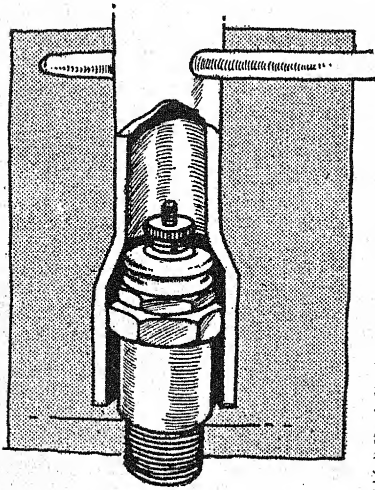
Using the Spanner.

287 Every car should be provided with a set of solid-ended spanners which will fit every nut and bolt in the vehicle. This is not at all an impossible thing, as both English and French screw pitches have standard sizes for every nut and bolt head from ⅛in. upwards. If every vehicle were so provided, the outfit of spanners would not be excessively large, as there is not a wide range of sizes employed. Anyhow, a screw spanner should be included in every outfit, in case of a solid spanner being mislaid, or in the event of a nut or bolt head not being properly gauged so that a spanner will not fit it. Unfortunately, this is only too frequently the case, and one finds a spanner marked, say, for ½in. nuts and bolts, which, when one comes to use it upon that size nut or bolt, is found to be too big for it. In such cases the screw spanner, of course, comes in extremely useful. In other instances one is by force of circumstances compelled to use a larger size spanner upon a nut than it is intended for. In some cases the difference between the two is not a great deal, and many use the spanner so long as it will hold on to the nut. The natural consequence of this is that the corners of the nut get pulled off, and instead of having nice flat sides to the hexagon, it eventually becomes a mere ragged circle; in fact,

it may be described as of no shape at all. Instead of being subjected to such treatment, the spanner should be packed up to fit the nut, and this may easily be done by means of a copper coin. In instances where the spanner is so large that it will not fit at all, it must then, of course, be packed up until it does so. This is particularly the case with the union nuts of the pipes in connection with the water-cooling system, as these nuts, being made to gaspipe pitch, have a different standard.

Box Spanners and Sparking Plugs.

288 When using a box spanner to remove or replace a sparking plug, care should be taken to see that the spanner does not rest on the porcelain of the plug. Recently, while replacing a plug, on removing the box spanner, it was noticed that the porcelain was cracked. Thinking this was a faulty plug, another new and sound plug was put in, with the same disastrous result. On inspection it was evident that the inside of the box spanner shouldered on to the porcelain of the plug, with the result that when pressure was put on the spanner the porcelain cracked. When using a common open-ended spanner equal care should be taken of the porcelain. It sometimes happens that the jaws of the spanner are rather thick, while the hexagon of the plug is somewhat low and very little larger than the porcelain, so that the jaws of the spanner are working in very perilous proximity to the porcelain, which is consequently apt to get an unlucky tap, especially if at all inaccessible.



Tightening Nuts.

289 When tightening up a nut or bolt, the operator should use discretion in the operation, otherwise he is liable to strip the nut or break a bolt or stud, as the case may be. It sometimes happens in tightening up union joints on oil or water pipes, that the end of the nut is burst away.

This happens because the operator, not finding the nut offer much resistance, continues screwing as if it were an ordinary nut and the leverage usually obtained is sufficient to break the nut without its being known, until it absolutely slips over the pipe. Nuts or bolts tightened from above work from left to right; when tightened from below, in the opposite direction. This is a little point which is often forgotten, and when the nut is located beneath a part, the natural action is to turn it in the same direction as if it were on the top. The result is tightening instead of slackening, or *vice versa.* Box spanners are included in many outfits; but as these are made for standard size nuts, there is no need to comment on them. We have before stated that it is necessary to include a good and well-made adjustable spanner in the outfit, and we would here emphasise the word "good" as we have had some lamentable specimens of this useful tool offered to us and recommended on the strength of the statement that it is a pattern supplied to large firms. There are several good makes of spanner upon the market, and it is only false economy to buy those of the cheap and nasty type.

Paraffin plus Patience.

290 We do not think the penetrating powers of paraffin are fully appreciated. When a nut or bolt sticks and cannot be unscrewed with a spanner as long as one dare use for the particular nut or bolt, paraffin is the remedy. It should be squirted all round the stubborn thread. From time to time we have been told by motorists to whom we have suggested this method that it has failed. Except in quite unusual cases this failure has been due to lack of patience. It must not be expected the moment the paraffin has been applied to the thread that the trouble will be over. The nut or bolt should be left for several hours for the paraffin to soak in; then it is almost certain to penetrate. When the nut is in such a position that paraffin runs away without soaking into the thread it is necessary to rig up some little dodge for stopping this. A simple way is to wrap a rag round the nut and thoroughly saturate it in paraffin, or, in extreme cases, to file a little channel on or about the nut or bolt head, so that some of the paraffin is retained and left to soak into the thread. A very good instance of the penetrating and freeing power of paraffin was afforded us recently. On one of our cars the caps over the valves take the form of large gun-metal plugs, which are screwed into the valve chambers by a box spanner with a 2ft. lever. When starting to remove

one of these we found it impossible to stir it. All we could do was to bend the lever. Of course, we might have got a longer lever but we did not consider it safe to apply any greater force, so contented ourselves by giving the plug a copious dose of paraffin and leaving it till the next day. After twelve hours' soaking the plug came out quite easily. Where time is of importance the part to be unscrewed may be warmed with a blowlamp and then the paraffin will penetrate much more quickly. When the nut cannot be heated the spanner (not a good one) may be heated and put on the nut to warm it.

The Hammer.

291 This is such an everyday tool that it seems almost superfluous to mention it; but, nevertheless, there is some art in using the hammer in connection with mechanical contrivances and movements. For instance, the tool should not be used upon a cast-iron piece as though it were a lump of coal; for whereas it is desired to break the coal, the iron is intended to be preserved, and to this end the hammer should be used as little as possible on cast-iron parts, as owing to their brittle nature it is the easiest thing in the world to crack or break a casting. When it becomes necessary to employ the hammer at all it should be used carefully and with moderately hard blows, which should be distributed over the largest surface possible, *i.e.*, repeated blows should not be given upon one place where it is possible to deliver a series of blows over a large area which will ultimately have the same result.

Removing a Bolt.

292 An instance where a hammer should be used carefully is in dislodging a bolt which fits somewhat tightly in its orifice. When the nut is completely removed, careful aim should be taken with the hammer, and one sharp decisive blow given to the bolt directly upon the top and with the centre of the face of the hammer.

It is, of course, perfectly clear that, if the bolt be struck at all sideways, the screw thread will be burred and prevent the nut being again replaced until the thread has been restored by means of a triangular file or by the edge of a square file—methods which do not conduce to the satisfactory working of the screw thread. Where possible, it is far better to slack off the nut until the top is level with the top of the bolt, with at least $\frac{1}{8}$in. intervening between the top of the nut and the face of the piece, when so much care need not be

exercised, as there is no danger of spoiling the thread. In some cases it is even advisable to screw the nut half-way off the bolt and deliver the blow on to it rather than spoil the thread itself, but it will be understood that it is injudicious to deliver heavy blows in this instance, as the force of the blow will be borne by three or four threads only.

Straightening a Rod.

293 This is another operation where it is inadvisable to use a hammer alone. It would be far better to place the rod between two pieces of hard wood, into which a groove has been cut, for preference. When the blows are given direct to the rod the surface is left indented with the hammer marks, which, if the part has to work through a guide, is liable to cause it to bind; and even if it is not working through such a guide, it is at least unsightly, and an evidence of bad workmanship to see such marks on any part of the car.

Riveting.

294 In riveting two parts together, or where the end of a bolt is riveted to prevent the nut working off, the face of the hammer should not be used. The ordinary hammer is provided with what is termed either a ball or flat pane. The ball pane is, of course, the spherical face, while the flat pane is more of the blunt wedge form. For riveting, the ball pane is preferable. The rivet should be held up tightly by the head, while the opposite end is riveted over. To commence the process, the edges of the rivet should gradually be worked over, going all the way round with the ball pane, and working up to the centre so as to leave the form of a half-round head, from which the indentations may be removed by means of a flat face of the hammer so as to leave as neat a finish as possible.

The Chisel.

295 This is a tool which does not figure in every automobilist's outfit, yet it is one of those tools which, when it is wanted, is wanted badly. The usual "cold chisel" is made in octagonal cast steel in sizes which vary from ½in. to 1in. in section and about 6½in. long. To get a thoroughly reliable tool, it should be forged, hardened, ground, and tempered by an experienced toolmaker. Though it looks a perfectly simple job to use a chisel, when the novice comes to handle it, unless care is taken, sore hands and barked knuckles invariably follow. All that is required is a steady hand and eye. Put the edge of the chisel where the cut is to commence, and strike a deliberate blow fairly on the head.

The chief thing to observe is to hit the chisel squarely upon the head, so that the full force of the blow is delivered to the cutting edge. If the blow is struck the least bit sideways, the force is at a greater or less angle to the cutting edge, the result of which is, the tool jumps from the work, and a piece of skin frequently flies off the left hand, or the edge of the chisel is broken off.

Files.

296 Two or three of these indispensable tools should be included in the outfit of every motorist. Generally speaking, the most useful sizes to carry are 6in. long and of flat and half-round section, of a "cut" known as "bastard," this being between the rough and smooth files. There is really an art in using a file, more so than would be imagined, for the mechanic who can file flat has something to be proud of. As it may happen that a flat surface has to be filed up at times, the method of arriving at this will be of interest. If an appreciable amount of metal has to be removed, the file should be used across the metal at an angle of 45°, first in one direction and then in the other, so that the file marks make a right angle to one another. When almost sufficient metal has been removed, the final touches must be given by "draw filing," preferably with a fine-cut file. This is done by taking the file in both hands, and holding it at a right angle across the piece, draw it backwards and forwards along the surface, using a gentle pressure. It will be noticed that the first file marks invariably show in the centre of the surface, and work down until they reach the edges. If a fine file is not at hand, it is better to reduce the cut of the "bastard" by filling the teeth with a little chalk and oil. In filing flats on spindles for keys, the above method is always employed. In reducing the diameter of a short rod or spindle by filing the "drawing" action should always be used. The most difficult of all files to use is the round one, and when a perfectly round hole is required, it should never be touched with a file, but reamed out, only the roughest of work being touched with a file, so far as enlarging holes is concerned. A file which should be carried is a flat watchmaker's for truing up platinum contact points.

The Usefulness of Tin Snips.

297 Among little odd hand tools in the motor house nothing is much more useful than a pair of tin snips, which may be bought at any ironmonger's for a shilling or so. These snips are not only useful for cutting tin, sheet

brass, and so on for making metal washers or any other little "gadget," but they are quite the best thing for cutting leather washers. Of course, the best way to cut leather washers is to have a set of leather punches, but as all sorts and sizes are required, quite a battery of punches is necessary, and a really complete set would be very costly. On the other hand, ordinary scissors are not successful in cutting any but the thinnest leather, but the tin snips do the work as easily as possible.

Pliers.

298 There are several patterns of this most useful tool, two of which are usually to be found in the motorist's well-appointed kit, *i.e.*, flat nose and gas. In addition to these, many also carry a pair of the round-nose type, which are particularly useful on occasions. The ordinary pattern flat-nose pliers are more or less unsatisfactory tools, as the manner in which they are jointed only permits of their obtaining a hold upon a narrow surface of the jaws. Those fitted with toggle-jointed jaws are preferable, as they are thereby always kept parallel, and a firm grip is obtained. A pair of $\frac{3}{4}$in. gas pliers—which will hold a circular piece up to $1\frac{1}{8}$in. outside diameter—is a very useful tool to have in the kit, as, if necessary, it may be used to tighten up nuts, but only in dire emergency.

Lifting Jacks: Their Choice and Use.

299 A lifting jack is one of the most necessary of the accessories which make up the outfit for an autocar. A jack should be obtained which is a suitable height for the car, and when purchasing this useful adjunct it is advisable to have one or two details of the car at hand. In the first place, the distance (with deflated tyres) between the ground and the axles should be known, so that the jack can be used instantly when required without the trouble of packing up the car. Another little point is the length of the handle employed to actuate the jack. This should be long enough to enable the jack to be manipulated without the operator being obliged to crouch under the car.

Jack too Long.

300 If the jack is found to be too long when the time arrives for placing it in position, the problem to be solved is how the car is to be lifted. A method of overcoming the difficulty in an emergency is to put the jack into position (we will presume it to be under the back axle at an angle), and then to push the car backwards against the resistance offered by the jack. The power should be put on to the car

forcibly, but not suddenly, for if any great amount of force is used the car will mount to the top of the jack, and owing to its momentum will run over to the other side, in which event one's labour will be in vain. If, on the other hand, only sufficient energy is exerted to lift the car on to the jack, it will rest comfortably in position.

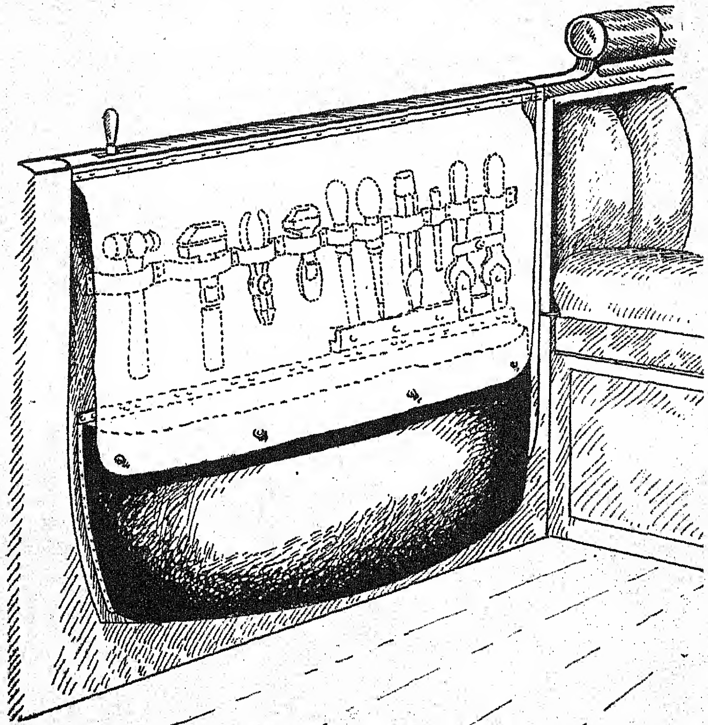
How to Carry Tools and Spare Parts.

301 Much noise and annoyance are caused by the rattling and jingling of spare parts and tools when carried loosely in the toolbox. Apart from the risk of damaging such parts as spare valves and ignition plugs when carried in the haphazard manner in which one often sees on quite first-class cars, there is always some trouble experienced in finding the part or tool required when necessity arises. If a proper box with partitions for each tool and part is not fitted, then the spares should be carried in separate wooden receptacles, such as cigar boxes; but they should previously be wrapped in waste or cloth to prevent knocking against each other and the box. Washers and nuts could be strung on copper wire, whilst the larger tools, such as spanners, files, hammer, screwdriver, etc., should be rolled up in a strong rough cloth. When wound over and over so that no two tools touch each other, the package can be put in the toolbox, and the space left filled up with waste or cloths, so that any chance of rattling is thus quite eliminated. Of course, in cars fitted with properly partitioned toolboxes such precautions are not required. Oilcans should, where possible, be carried in a different place from the spares and tools, as invariably the oil leaks out of the can if it becomes overturned, and the resulting oily mess found in the toolbox when the tools are required does not appeal to those who wish to keep clean hands when driving a car. Usually a spring clip or small rimmed shelf to carry the oiler can easily be fitted on the dashboard, inside the bonnet, or in some other convenient place.

A Simple Tool Carrier.

302 The chief objection to carrying tools loose is the difficulty in locating the tool required, whilst a tool roll must be found, undone, done up, and replaced each time a tool is required. My suggestion for overcoming this can easily be grasped from the accompanying drawing. The idea consists in attaching a tool-carrying strip to one or both of the side doors, the strip being arranged loosely so as to form loops in which the tools are carried, as in the ordinary tool

roll. A background should be made of baize, of the same colour as the car, so as to prevent any noise, and the tool-carrying strip may be of the same material or leather. A patent leather flap can then be attached to the door so as to cover the row of tools. A neat method of attaching the flap is first to separate the upholstery from the woodwork,

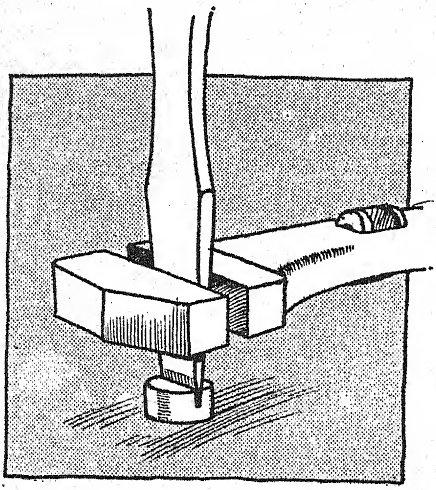


A suggestion for carrying tools in the side door pockets.

then insert the edge of the flap, the upholstery being replaced so as to hold the flap. Beneath the row of tools can be arranged a pocket, as shown, to carry odds and ends, or such tools as cannot be carried in the loops.

This idea can be improved upon, as shown at the right-hand part of the sketch. Here is shown a wooden channel,

which is attached to prevent the tools falling through the loops, whilst further to the right are shown spanners which are supported by bevelled tongues of wood, and secured by a wooden cleat, which clamps both the spanners in place. These cleats and wooden carriers can be devised for each individual tool, but this has not been shown the whole way along the sketch in order to show clearly the development of the idea.—E. W. W.



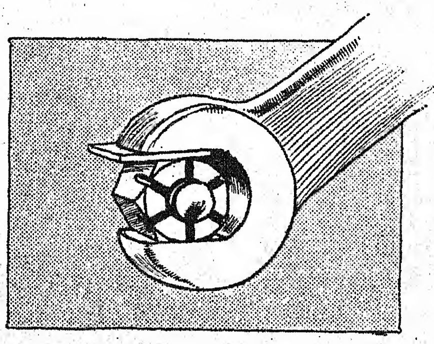
Undoing a stiff screw.

To Start a Sitff Screw.

303 Choose a screwdriver with a well-ground blade, which fits the screw head slot as accurately as possible. With one hand press the screwdriver hard home, and with the other apply a wrench oi spanner, as shown in sketch.

How to Make Shift with a Spanner a Size or two too Large.

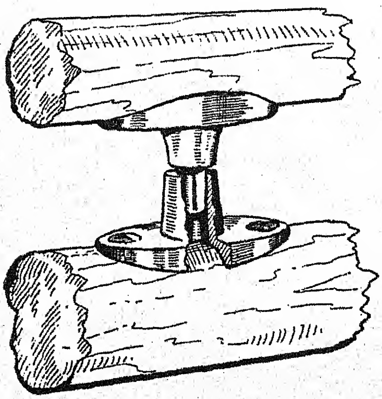
304 After applying spanner to the nut or bolt head in the ordinary way with the one hand, and before beginning to turn it, pack it with the blade of a screwdriver, or with a bit of metal or hard wood held in the other. The method will be perfectly understood by the aid of the accompanying sketch.



Using a large spanner

Repairs and Spare Parts.

305 Before sending your car into any garage for repairs, it is always advisable to remove all the tools, spare parts, lamps, etc., if they are to be kept intact and in good condition. Failing this, the next best thing to do—or perhaps it may be the better method—is to hand the parts over to some responsible person, with the request that they may be separately stored. We do not imply by this any dishonesty on the part of the principals or workmen, but it is a fact that a spanner or other tool is borrowed from the car, with every intention of its replacement, but is forgotten, or, maybe, another workman comes along and picks up the tool without knowing to whom it belongs. Again, a lamp may be taken for the purpose of forging a new lamp iron, but as no one takes any particular interest in it, there is the possibility of its being lost before the car is completed. If the workman has to obtain the lamp from a foreman or manager, and to return it when it has been finished with, there is no risk of its departing from its proper course. In all the best repair shops proper lockers are provided, in which the spares from each car are carefully and separately stored till the car is once again ready for the road. Of course, in all motor works worthy of the name the same system has long been adopted.



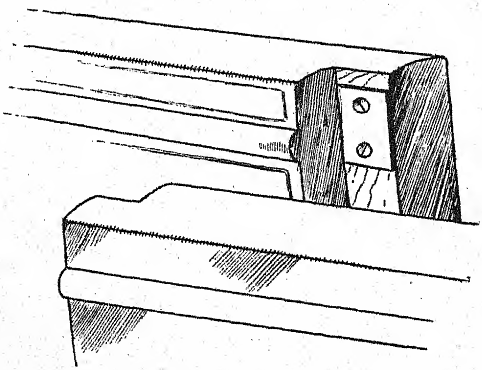
Separating studs as illustrated above should be fitted to the sticks of Cape cart hoods. Their functions are referred to in Hint No. 307.

CARRIAGE WORK.

To Stop Doors Rattling.—The Right and Wrong Way of Folding a Hood.—A Panel Shield.—Guttered Front Edge Hoods.—Mysterious Body Noises.—Fitting Back Screens and Scuttles.—The Width of the Wind Screen.—Front Mudguards.—A Single Side Curtain.—To Prevent Rattle in Bonnets.—Bonnet Retainers.—Washing a Newly-varnished Car.—Washing the Car.—Mud from Town Roads.—Cleaning Enamelled Leather.—Preparing Brushes for Cleaning Cars.—Cleaning Unvarnished Grey Bodies.—To Remove Tar Stains.—Rain Spots on Varnish.—Rain Stains on Bonnet.—Cleaning Mica Windows.—Carriage of Spare Tyres.—Collapsable Table and Wind Shield for Back Seats.—Glass Driving Screens: A Tip for Wet Weather.—Squeaking Car Springs and How to Cure Them.—Buying a Cape Hood.—Protecting Varnish and Bright Parts.—After Varnishing.—A Good Anti-vibrator.—Draining Undershields.

To Stop Doors Rattling.

306 After a car has been in use some time, especially if the body be rather weak, the wood unseasoned, or



the frame unduly springy, the doors will rattle. Although the actual play is very small, it makes a most annoying noise,

and in these days of quiet engines and quiet transmissions body rattles and body squeaks are exceedingly irritating. All that is necessary to stop a rattling door is to get a thin brass plate, or, if preferred, one may use a thin piece of fibre or leather, and fix it on to the doorpost as shown. Of course, a little judgment is required. One should see that the thickness of the plate is only infinitesimally greater than the amount of play in the door, and if the door is loose all the way down another plate should be fitted about 1in. or so

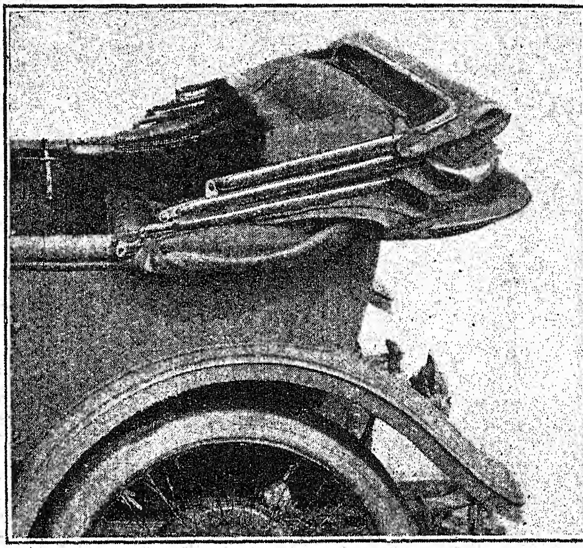


FIG. 1.—A hood folded incorrectly, so that the canvas material overlaps the upholstery.

from the lower end of the door jamb. The sketch shows the idea quite plainly. It is obviously a makeshift, but there is no other easily applied remedy, as nothing but entirely refitting the doors would stop the looseness, and this would necessitate repainting.

The Right and the Wrong Way of Folding a Hood.

307 It is evident that many motorists do not know how a hood should be folded, as one sees so many which are wrongly folded, the hood material being allowed to drape the back cushion of the rear seat when the hood is dropped.

This wrong position is shown clearly in fig. 1, in which it will be seen that the draping of the back cushions is likely to give rise to considerable discomfort due to the unsuitability of hood material for an "antimacassar" and to the amount of dust and dirt with which it is likely to be plentifully besprinkled. The correct position of the hood when folded is shown in fig. 2, which shows the hood material clear of the cushions and neatly tucked away behind the back panel. This ideal result is arrived at by the method shown in fig. 3.

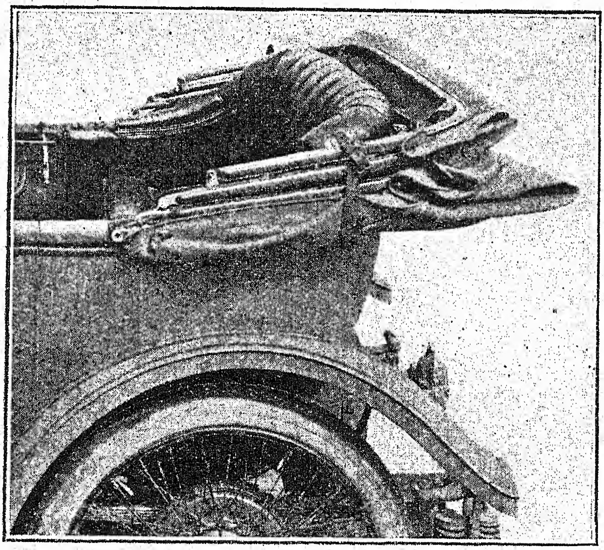


FIG. 2.—The same hood folded correctly. Note that the canvas is quite clear of the upholstery, and yet the overhanging portions are none the less neatly arranged.

On folding the hood and dropping the hoop sticks it will be found that the hood material, if left to its own devices, will almost always fall inwards, the main stretch drooping over the cushions. If, however, the operator, whilst lowering the hoops, prevents the material from falling forward in the manner shown in fig. 3, it will be found that the whole of the material will be neatly tucked away free of the upholstery. Before the fixing straps are put on, the corners of the hood should be tucked in, and any obtruding straps or buckles

hidden in the folds, but care should be taken not to get them so placed that chafing of the material may occur.

We assume that all careful owners nowadays have separating studs fixed on their hood sticks. These are little brass studs and sockets, such as illustrated beneath Hint No. 305, or their equivalents, which prevent the hood sticks from coming

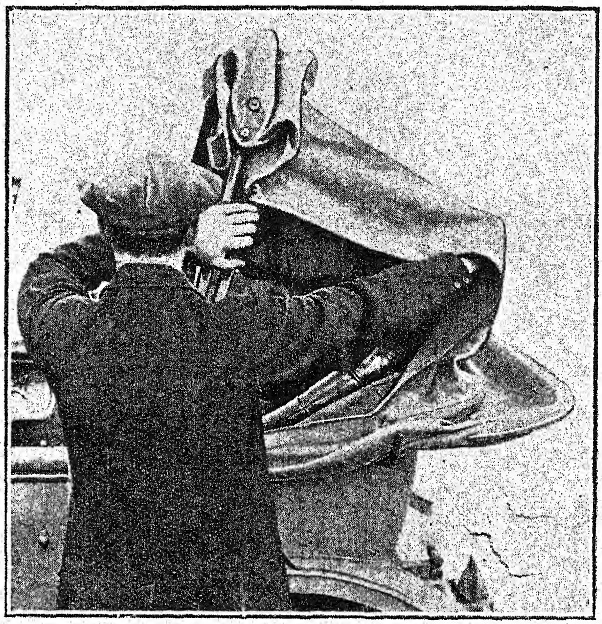
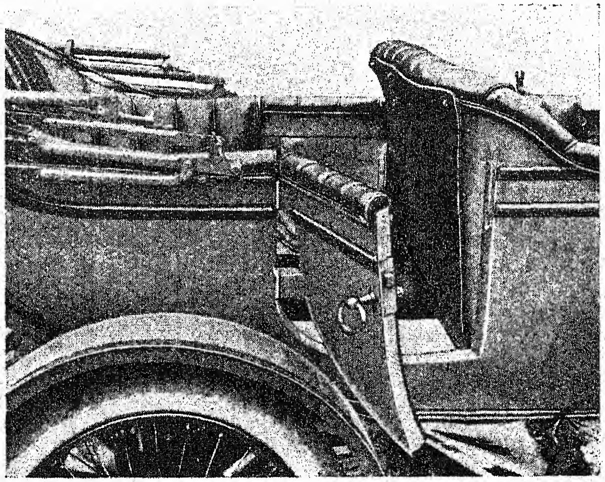


FIG. 3.—The manner in which the main stretch of the hood should be restrained from overlapping the back of the seat as the hood is dropped.

quite close together when the hood is folded down, so that the hood material is not chafed between the sticks. If these separating studs are not employed it does not matter how good the hood material may be, it will very quickly be rubbed into holes, as there is always slight movement of the hood, be it strapped down never so tightly.

A Panel Shield.

308 This illustration depicts the felt shield fitted by Mr. H. Joyce, of Birmingham, to the back panel of the front seat of his Calthorpe car. It will be noticed that this shield is secured near the floor and by four fasteners at the top of the back panels. The car on which this appears is a 12-14 h.p. Calthorpe, with 8ft. 6in. wheelbase. This dimension necessarily gives comparatively little room in the back for luggage, and consequently without some such shield as that shown the panels of the front seat would be likely



to suffer considerably when luggage was carried, even if the luggage consisted only of small bags. We have an idea that this shield could be further improved upon by enlarging it somewhat with a fold, so that it might be used in wet weather as a waterproof rug for the use of the back passengers.

Guttered Front Edge Hoods.

309 "Driving a strange car recently," writes a correspondent, "I was disconcerted by a constant shower of drops of water blown back into my face in rain, and apparently coming from the front edge of the hood. My own car is free from this nuisance, and comparisons elicited the fact that its foremost edge is provided with a gutter, which

catches all water that runs down the tilted fore portion of the hood and sweeps it away to the sides, where it is innocuously blown backward and away from the occupants of the car."

Mysterious Body Noises.

310 A good many creaks, groans, and rattles on a car come from the body and bodywork, and many a silent chassis is spoiled thereby. Of course, it may be due to bad bodywork through poor workmanship and unseasoned wood, but there is one cause which may affect the very best bodywork, and that is the careless way in which people treat their cars. If they draw up at the side of a road to admire a view or to enjoy an open air meal, in many cases they turn the car on to the grass, or half-turn it on, so that one side of it is down in the gutter, one wheel on a high grass mound, and perhaps the other in a depression in the grass. Perhaps the car is left in this position for an hour or more, and it will often be found impossible to shut the doors or latch the bonnet until it is driven off the grass on to the road again. This carelessness means the whole time the car has been standing the frame has been more or less deflected, and it is very apt to strain the body, so that doors which were hitherto silent begin to rattle or the body to creak. It is always well, therefore, to see that the car is not left in a position which sets up these needless strains.

Fitting Back Screens and Scuttles.

311 Great interest has been taken in the fitting of screens and scuttles to the back seat of a car, so that the occupants of the rear seat may be as well protected from strong air currents as those on the front seat. There are already some very clever combinations of screens and " lids " or scuttles which have been illustrated in *The Autocar* from time to time, but a good many of our readers desire to experiment cheaply for themselves before definitely ordering a back scuttle and screen from their coachbuilder, as they do not feel sure that the extra comfort will be worth the outlay. Recently when answering a correspondent who desired to try something of the sort experimentally and cheaply, we recommended wickerwork as probably the cheapest way in which he could get a trial scuttle and screen made. The scuttle and screen would have to be covered with canvas or a cheap imitation leather, and, of course, the screen would be opaque, but the affair would be quite satisfactory for trial purposes, and the screen need not be made so high that the occupants of the back seat could not see over it. Basketwork is so

cheap that if the proportions of the first attempt were found unsuitable, it would be a very small matter to have it altered or remade. For this work we should not recommend close wickerwork, but open, as little more than a frame to support the canvas or other covering properly is required. The greatest essential is some little ingenuity on the part of the motorist, so that he may temporarily fit the scuttle without damage to the car, and, moreover, arrange it so that he may easily vary the angle and height of the screen portion. This is quite easy for one possessed of a little ingenuity, but if this essential be absent we should advise the motorist to attempt no experimenting on his own account.

The Width of the Wind Screen.

312 The standard width of a wind screen is about 40in. On a prolonged drive rain may be prevented from blowing in at the sides of the front seat in the gap between the hood and the screen by means of curtains, but such curtains cannot be used by doctors and others who make frequent stoppages and dismounts, as the labour of unbuttoning and replacing the curtains is too tedious. In such cases the only satisfactory plan is to specify an exceedingly wide dashboard and wind screen, protruding sufficiently to protect the occupants of the front seat from rain even in a strong cross wind. At the present time we have a car with a wind screen 4ft. in width. It does not look at all unsightly, and although no side curtains are fitted to the hood, the occupants are kept dry even when rain coincides with a strong cross wind.

Front Mudguards.

313 It is evident from the state of many cars after being driven over muddy or wet roads that a very large proportion of them are fitted with unsuitable front mudguards. In many cases the contour of the mudguard is quite good. It is brought well forward over the wheel and comes right down to the footboard aft. It may also have good inside extensions, so that the mud will not escape between the guard and the frame either on to the bonnet, dashboard, or stepboard. Yet the fact remains that whenever the car is used on muddy roads, splashes escape in such quantity that the car becomes smothered from end to end, and as often as not the occupants of the back seats become bespattered with splashes and spray. Till the matter is looked into these splashes at the back are often assumed to come from the back wheels, but it is very rarely they do, and it is hard to understand how they escape the front guards when, as we have said, these are of excellent

contour with the inside flaps and outside flanges. From experiments we have made we have found that the trouble is due to the fact that the guards are not placed close enough to the wheels. What is not realised is that the movement of the front wheels up and down as the springs play over the road is less than that of the back wheels. It may be, and often is necessary, that the clearance between the wheel and the guard for the back shall be anything between 7in. and 10in., but for the front wheels anything above 6in. is very rarely required, and in many cases a smaller clearance can be allowed quite safely. If is, of course, very necessary that the tyre should never touch the guard, as if it does the guard is almost sure to break off in time, and if the tyre touches at the spot where the guard is fixed to the wing iron it is most likely that the tyre will be damaged, as one of the nuts of the bolt holding the wing and the wing iron together will probably cut the cover.

On the other hand, anything more than safe clearance is objectionable, as it results in the mud escaping unless the front wings are made extremely wide. It is necessary to bear in mind that anything which escapes the front guards drifts all along the car, and that guards which pass mud in wet weather pass dust in dry weather, so that the occupants of a badly guarded car are not only spattered by mud, but they will be continuously breathing dust-laden air in dry weather; not the dust from other cars, but the dust thrown up by the wheels of their own car. We recommend all who are dissatisfied with the mud-stopping properties of their front mud-guards first to assure themselves that the guards are of the right shape, and having done that, to consider how much needless space there is between the guards and the tyres, and, if it can be safely reduced, to have it reduced by the simple expedient of shortening the irons. To ascertain the correct clearance, the best way is to take off one of the front wings, leaving the wing iron in position, and then to drive the car freely over a few such obstacles as road crossings and cross gutters, so as to cause it to bound in the ordinary way. The driver should have a companion with him, whose one duty would be to observe how near the wheel came to the guard iron, which would serve as a sort of gauge, and from which it could easily be seen whether it would be safe to reduce the clearance or not. It is also a good plan to shake the car up and down on its springs in the garage, watching how near the tyre comes to the guards. This sounds rather like suggesting a Herculean feat, but it is comparatively easy for a weak

man to get a large amplitude of motion on the springs by lifting and depressing the dumb irons very slightly to start with, and as the springs respond, to continue the effort and the movement so that by timing his actions he can get quite a big bounce on the car without any heavy individual effort.

A Single Side Curtain.

314 Many motorists who have had a pair of detachable side curtains to their hoods have carried them about with them for years without once using both simultaneously. They have merely put up one on the windward side when driving in a strong wind with hail, sleet, or snow in it. They find that the two side curtains make the car insufferably dark and uncomfortable, but they carry two about the country with them because they never know which one they will want. We have solved the difficulty by the very simple expedient of having a single curtain which will fit on either side. It means such a trifling modification of the ordinary eyelet holes and buttons that there is nothing to explain to the coachbuilder. It is simply necessary to tell him that a single side curtain to fit on either side is required. Incidentally while having this single side curtain, it is best to have it long enough to shelter the driving seat as well as the back seats. Space on so many cars is so valuable that the additional storage room for two curtains, when one only is likely to be used at a time, is to be begrudged.

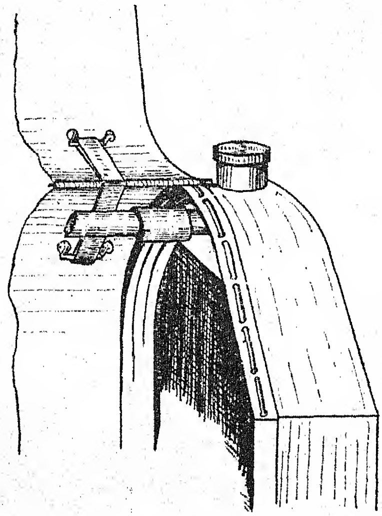
We would issue a warning note on the subject of side curtains to the driver's seat. We recently heard of a case in which an accident was imminent owing to the driver finding, when he had made himself secure against the inclemencies of the weather that, although his gear lever was accessible, being inside the front door panel, the brake lever, being outside the body, could not be used without unbuttoning the curtain!

Needless to say, one should note whether all the control levers are readily accessible before attempting to drive after securing the storm curtains.

To Prevent Rattle in Bonnets.

315 No part of a car receives such scant attention as the bonnet, and yet what would otherwise be a pleasant run is often completely spoilt by the nerve-racking rattle and clang of a bonnet loose on its hinges and with its fastenings adrift. One of the most useful materials for allaying the nuisance, and which should go a long way towards prevention in the case of a new car, is leather. In the case

of a bonnet which is hinged along the ridge and again along the side, great strain is thrown upon the ridge hinge when the bonnet is doubled back. The hinge can be easily relieved of all this strain by having two pairs of stout metal loops well riveted inside the bonnet—a pair at each end. These loops should be placed one on each side of the ridge hinge, and should be wide enough to accommodate a buckle strap about 1¼in. wide, which should be so adjusted that when the bonnet



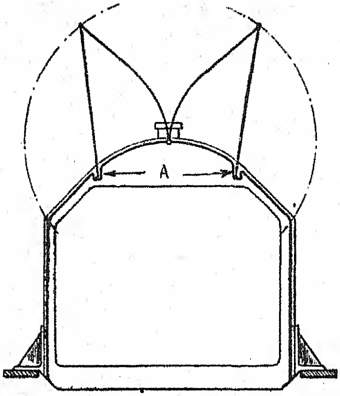
Leather buckle straps and laces prevent rattling bonnets.

is doubled back the straps, and not the hinge, take the weight of the bonnet. This description is made clear on reference to the accompanying illustration.

When the bonnet is closed there is often noticed a decided rattle between the bonnet front and the lip provided on the radiator to support the bonnet when closed. This rattle can be effectually cured by drilling a series of pairs of holes and interlacing a wide leather strip—say a lace as used for joining up machine belting. This soft leather, forming a cushion between the metal of the bonnet and the lip of the radiator, thereby stops all rattle.

Bonnet Retainers.

316 Owners of cars fitted with bonnets which open at each side must have experienced one objection to bonnets of this type. That is, that the two sides of the bonnet cannot be held open simultaneously, and that the open part of the bonnet has to rest on the closed part, to the detriment of paint and varnish. Some cars are fitted with the arrangement we illustrate herewith. The two frames upon which the bonnet rests are provided with recesses, and the sides of



A support for divided bonnets.

the bonnet are so proportioned that the ends of the lower edges can drop into these recesses, so that the two sides of the bonnet can be held open simultaneously, as shown in the drawing, without any detriment to the varnish. Most existing bonnets can be modified so that this effect may be obtained, and it will be found that it is a great advantage over any strap or chain arrangement.

Washing a Newly-varnished Car.

317 A newly-varnished car should stand for at least a week before being taken into regular use. This is in order to allow the varnish to set properly. Frequent washing with clean cold water and careful drying with chamois leather and exposure to fresh air in the shade will both harden and brighten the finish. In washing a carriage, plenty of water should be poured carefully over the parts; it is always a mistake to use a swift-flowing hose jet. It is really better

to use a large sponge, well saturating it and squeezing it over the panels of the car body, when the water, in running off, will carry the mud with it. Never allow water to dry on the carriage, as this is very liable to stain, almost as much so as mud. Hot water and soap should never be applied to any varnished or light-coloured painted surfaces. If mud is allowed to remain on the car, it tends to make it very dull, the varnish is spoiled, and what would otherwise appear as a smart turnout will then partake of the nature of a shabby, dilapidated, second-hand affair, not worth nearly the amount which it really is. All the paintwork being then dry, or very nearly so, a gloss and polish can be put upon the work by clean, dry Selvyts and plenty of elbow grease. When leather upholstery has been wiped perfectly clean, and all dust and damp removed, it can be brought up and made to look like new by liberal rubbing with Rolledge, a special and excellent preparation for the purpose, which can be obtained at most motor depots and garages. Throughout the washing process every care should be taken to avoid water being splashed into the carburetter or the air pipe. The wiring should be kept dry; in fact, this refers to the entire ignition installation, whether it be by accumulators or by magneto.

Washing the Car.

318 Everyone knows that after a muddy drive the car should be washed immediately it comes in. However, there are times when circumstances make it almost impossible. If the varnish is well set it may not matter, but when the drive in the wet has been a very long one, and the back panel of the car is thoroughly plastered with mud, it, at any rate, should not be left unwashed. As a matter of fact, there was no great harm in leaving it for a few hours before the days of road tarring, but now one runs the very greatest risk of spoiling the paint upon just the parts where it shows most, *i.e.*, the back panel, wings, and one or two other places. We are not referring to roads which have been freshly tarred. Everyone knows that they do harm to the paintwork, but stretches which have been tarred weeks previously "pick up" on a very wet day, and here and there a black spot of tar is deposited with the mud on the back panel. It does no harm if it is washed off while the mud is liquid, but if the whole coating is left to cake the car will adhere to the paint in such a way that it is impossible to remove it without scratching, and the panel which was hitherto almost like a mirror will show little black spots, which can only be removed

by a coach painting expert, and even he will not be able to do it without some little scratching. Not only so, but some of the road preparations have a corrosive effect, and even if the back of the car is not spotted, the liquid mud may eat into the varnish if it be left on for a few hours, and give it a sort of mottled appearance, robbing it of all its lustre. Therefore we repeat, whenever the car is very dirty, wash the parts which are likely to be disfigured in the way we have mentioned immediately it comes in.

Mud from Town Roads.

319 The cleaning of motor car bodies is very much more important than the majority of motor car owners are apt to believe. Cars which are constantly driven in town and seldom in the country should be washed as rapidly as possible at the end of the day's journey, because the mud collected from the town roads contains impurities which are far more likely to damage the varnish work than ordinary mud which is collected from country roads. It is almost superfluous to say that buckets of water should be thrown over the body before a sponge or leather comes near it, otherwise the highly varnished body will be scratched by minute particles of grit. which will cut like diamonds. In winter, great care should be taken to prevent the water freezing on the paintwork, as it is liable to crack the varnished surface and cause it to peel.

Cleaning Enamelled Leather.

320 Enamelled leather hoods or aprons should always be washed with weak soap and water, after which they should be carefully dried off and then polished with a chamois leather. On no account use oil, as so many people are apt to do, as this has a softening effect on the enamel, which in time causes it to deteriorate and lose its polish.

Preparing Brushes for Cleaning Cars.

321 Not many owners of cars like the operation of cleaning them, this generally being left to some handy man or the regular driver of the car, where one is engaged. Fewer still know how to use a cleaning brush so as to obtain the best results, and make such brush last the longest time possible. When a new brush is bought the usual plan adopted is to put it to work at once, but this is not correct. The better way is to soak it in water for a couple of hours. This softens the bristles, and also swells the wood. Then the brush should be taken out of the water and allowed to get nearly dry, but not quite, it being left in the shade

during this time. Then it can be used with the certainty that it will shed fewer bristles than if it had been at once put to work. It will be found that if this tip is adopted the cleaning brush expenses will be reduced very considerably.

Cleaning Unvarnished Grey Bodies.

322 When mud and dust and water stains have been removed by ordinary methods with hose, water, and sponge, any surviving stains caused by grease, oil, and dirty fingers can be eradicated by rubbing with soft rags moistened with paraffin. Stains of quite long standing can be eradicated by these means, but with certain paints the paraffin may create a slight stain of its own, and therefore it should be applied to the whole area, say, once in three months, and not employed at the daily washing. Its effect is to reduce the depth of hue very slightly.

To Remove Tar Stains.

323 Several of our customers have suffered disfigurement of their cars by tar stains on the bodywork, and have asked us if we can tell them the best way to remove them. As it may interest many of your readers who are in the same plight, we write to suggest the following method as being the only one we have found up to the present to remove the splashes:

First, if the car is dusty, hose it down wherever the tar is sticking, preferably with lukewarm water. Dry off with a leather by dabbing, making no attempt to pass the leather to and fro across the surfaces. Having done this, take a piece of some soft material—such as the best woollen waste or linen—and charging it with vaseline or unsalted butter, rub the splashes until they disappear. It will be found necessary to change the rag frequently. Use plenty of grease. Then wipe off all superfluous grease, and wash the car down with lukewarm water and some body soap—such as Jellso. On no account leave the car standing with the spots on longer than is necessary, or they will permanently mark the varnish. This method has worked quite satisfactorily with us and well pays for the trouble it takes in doing it.—SIRRON CARS, LTD.

An alternative method is that suggested by Mr. H. Sackville Bryant, who writes: "I have tried many things, but find nothing so good as Fels Naphtha soap for removing stains without damaging the paint. The soap should be rubbed on a wet flannel and then rubbed gently on the stains till they disappear, afterwards drying with a washleather in the usual way."

Rain Spots on Varnish.

324 I have adopted the following method for removing rain spots on varnish, with great success: Well rub in linseed oil (boiled for preference) with a soft rag until all the spots have disappeared, afterwards removing all superfluous oil and polishing with a clean, soft cloth.—FRANCIS J. HARRIS.

Rain Stains on Bonnet.

325 When a car has had a run in heavy rain, particular attention should be given to the bonnet, as after a long run the bonnet becomes fairly hot, and if the rain drops be left to dry upon it they will stain far more than they will upon the body or wings. If circumstances do not permit of the car being washed down at once, the precautions should always be taken of sponging off the bonnet and then leathering it lightly to take up the moisture, otherwise it will spot so badly that it will never look smart again until it is repainted and varnished. Wet mud spots are just as bad as rain.

Cleaning Mica Windows.

326 So many hoods are now provided with mica lights that those who possess them may like to know that the best way to clean these lights is first to damp them carefully with vinegar, and then wash it off with clean cold water.

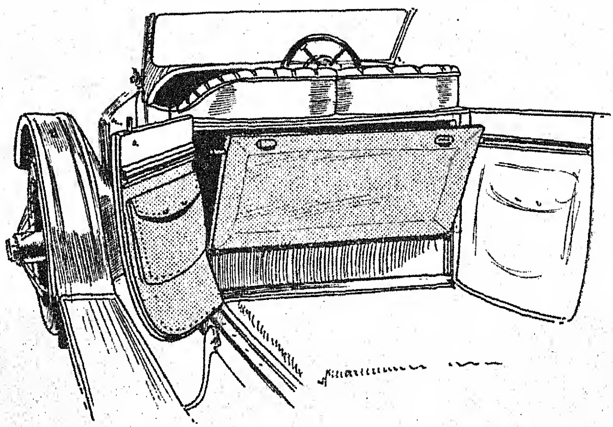
Carriage of Spare Tyres.

327 Most automobilists when starting on a long tour or drive, especially when the tyre covers of the wheels show signs of wear, provide themselves with a spare cover and air tube, in addition to those on the spare wheel or rim. The chief trouble in connection with the spare covers is that there is no suitable place provided for carrying them on the majority of cars. Many owners, for want of a better place, fasten them on the back of the car, and in many cases carry a spare air tube inside the cover, partially inflated, thinking they could not have a better place in which to carry it until it is required for the purpose of repair or replacement. In reality, no place could be worse for carrying an air tube than inside a cover, where it is, especially when fastened at the rear of the car, subject to all the dust and dirt thrown up by the hind wheels. This dust, with its small particles of grit, is carried inside the cover and settles at the bottom between the air tube and cover, acting like a rough file on the surface of the air tube, the vibration of the car rubbing the surfaces of the air tube and cover together, with the

dust acting like emery paper between. Air tubes should not be carried in this way. They should be folded up, and the valve wrapped up in rag, and placed in a special bag well dusted out with French chalk.

Collapsable Table and Wind Shield for Back Seats.

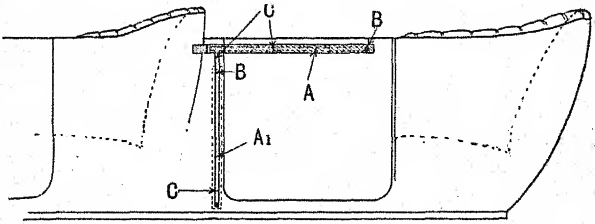
328 Some years ago a "Hint and Tip" was given showing how a combined table and draught stop could be fitted to the back-entrance bodies then in vogue, and we now give a drawing of a somewhat similar arrangement for a side-entrance car. The drawings are almost self-explanatory, and the mission of the table is two-fold. In the first place, it makes a most convenient table for roadside



Collapsable table and wind shield for back seats.

luncheons or teas, and in the second it keeps the occupants of the back seats delightfully warm, as it prevents the down draught over the back of the front seats, which is so chilling to the feet of the occupants of the back of the car unless they have exceptionally good foot muffs or foot warmers in addition to the usual rugs. In the old tonneau days the table was a fixture, because the entrance was at the back, but in these days of side-entrance bodies it is necessary that the table should quickly collapse flat up against the back of the front seats. There are many simple methods of effecting this, and our illustrations show one. The first sketch shows the table in the act of being drawn up from the closed to the

opened-out position, and the second shows it when extended for use either as a table or a wind shield. It is a great comfort on cars which have rather a long space between the front and the back seats, as these are notoriously cold, and there is so much wind playing around the feet that it is difficult to keep the rugs in position. With this wind shield this difficulty is entirely overcome, and the back of the car made delightfully cosy. Its uses as a table are too obvious to need recapitulation. We should add that to work satisfactorily it is necessary that the table should be thoroughly well made by a good coachbuilder, otherwise it will rattle and will not work easily. When properly made it can be pushed out of



The combined table and shield in section.

A, shield in position. B, guide pegs.
A1, shield out of use. C, grooves for side pegs.

the way for getting out of the car as easily and as quickly as one would throw aside a rug, but unless really well made it is stiff in action and apt to cause annoyance by rattling when going over rough roads.

Glass Driving Screens: A Tip for Wet Weather.

329 I observe that many drivers of cars consider a glass screen in front of the driving seat to be objectionable, because, although it is useful as a wind screen, it rapidly becomes obscured by rain or snow, and constitutes an obvious danger in driving. It may interest some of your readers to know of a very simple means of obviating this disadvantage to a great extent. I happened to see a notice of a mixture which is used in the United States for preventing the formation of frost crystals on house and shop windows. I determined to try it on my glass wind screen, and did so with great success during the winter. I found it useful both in rain and snow. If it were a very heavy fall of snow it would, of course, not be effective. The mixture is: Glycerine, fifty-

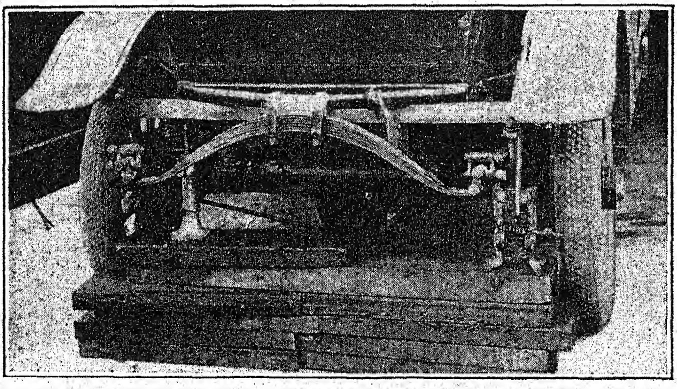
five grams; alcohol, one litre. I had a small bottle of this made in these proportions. In bad weather it was rubbed over the glass in the morning and allowed to dry. Rain or snow quickly slid down the glass, leaving it very fairly clear. On one occasion one-half of the glass was treated, the other half left in its usual state. The difference when it came on to rain was very striking.—N. B.

Other means of obtaining the same end are suggested by another correspondent. If the following method is employed it will be found effective in causing rain drops to slide off the glass readily and in preventing a coat of moisture from collecting in wet or foggy weather: Obtain a small quantity of semi-liquid or soft soap or make a paste of ordinary soap and water, and smear a little over both sides of the glass. Then with a soft cloth or a handful of waste rub the soap evenly over the entire surface so that a thin transparent film remains. If it be well distributed and well rubbed, so that all surplus soap be removed, it cannot be detected when the screen is dry.—A. P.

Squeaking Car Springs and How to Cure Them.

330 Many cars squeak distressingly on rough roads, and the owners are often puzzled, as they know that all the spring pins are properly lubricated. If you have a car which squeaks mysteriously, first of all satisfy yourself that it is not what, for want of a better term, we may call a mechanical squeak. That is, assure yourself that it is not caused by, say, an unlubricated universal joint or want of oil at the clutch collar. In fact, make sure that it is no part which is constantly revolving, as squeaks from an unlubricated shaft of any kind are very serious. Having satisfied yourself that all the running parts are properly lubricated, turn attention to the springs and brake rods. Oil all the pins and bearings, and if they are provided with grease lubricators, take off each lubricator, see that it is filled with nice soft grease, and before screwing it home again, push a wire into the hole in the spring pin and inject a drop or two of thin oil. Having done this, the squeak may be stopped, but it is almost impossible to study spring squeaks on the road. The way to find them out is to take hold of the dumb irons, one with each hand, and lift the car up on its springs. This may sound an Herculean feat, but no great effort is required, as if one pushes and pulls in sympathy with the compression and rebound of the springs, after two or three efforts the car begins to rise and fall 3in. or 4in. on its springs. If the springs

are dry, the result will probably be a most distressing chorus of squeaks, and nothing can be done to stop them while the weight is on the springs. The thing to do is to take a couple of jacks and put them under the frame so that the weight is lifted off the springs. To do this, it is usually necessary to use a stout piece of wood an inch or two wider than the frame and about 3in. square, as the jacks have to be placed inside the frame to miss the springs. The jacks will not be long enough to reach up to the wood, so it will be necessary to pack them up with some bricks or convenient pieces of wood. The illustration shows a car jacked up so as to take the weight off its back springs. Having carefully jacked up the car, the leaves or plates of the springs will come apart slightly.



The method of packing the jacks under the car by means of wood blocks. Note the beam between the car frame and the heads of the jacks.

They should be forced apart somewhat more than they come naturally by means of a stout screwdriver, and a copious dose of oil poured in between each of the leaves. Then a little grease should be pushed between each leaf by means of an old tableknife, or, better still, one of the flexible palette-knives which painters use, and which can be bought at any oil and colour shop or ironmonger's. The blade of the knife should be thickly greased and worked up and down between the leaves of the spring. When this has been thoroughly done, the jacks can be let down and the weight taken again by the springs, and the trouble of squeaking will be stopped probably for some months. The operation must be carried out both at the front and back of the car.

We may say that the operation does not merely result in the stoppage of spring squeaks, but the springs themselves work much more freely, and the car is much more comfortable over a bad road.

Another point to be borne in mind is that, while the weight is removed from the springs it is always well to lubricate the spring pins thoroughly, even if they are not squeaking, as the lubricant, especially if it be grease, will penetrate much more easily when the load is removed from the pins.

"The best lubricant for carriage springs is ordinary lead paint or 'grey priming' slightly thinned with raw linseed oil, and about 10% of graphite well mixed into the paint. This lubricant," says Mr. G. H. Lanchester, "lasts a great deal longer than motor or axle greases; in fact, it will generally outlast two or three applications of grease."

Buying a Cape Hood.

331 See that it can be swiftly erected. Some hoods take so long to unfurl that the passengers are drenched before erection is complete.

See that the tilt comes well forward over the bonnet, or else no protection for the front seat will be afforded.

If a wind screen be used in conjunction, see that provision, *e.g.*, a short drop curtain, is provided to fill any gap between the top of the screen and the roof of the hood. Otherwise discomforting draughts will sweep the rear body. Such drop curtain should button along the top of the screen.

See that there is a complete set of side curtains, especially to shield the front seats. Many hoods permit the front seat occupants to be quickly drenched in a side wind.

Eschew spring-push attachments for the curtains. They function very well while new, but may wear slack at any moment, and the curtains will then flap about loosely in windy weather. Turnbuttons are essential.

Be content with a very small rear window. A big window is sure to split or crack sooner or later, and however big it is, you will not be able to reverse conveniently by looking through it. Therefore have a window just large enough for the passengers to peep through.

PRECAUTIONS IN USING.

Never furl the hood till it is dry. If lady passengers insist on the hood being refurled when a shower is over, resist them to the death, if wife or blood relation; if guest or *fiancée*,

submit, but put up hood again to dry immediately on reaching garage, unless it be made of Kamac, which is the only material we have found which can be furled wet without damage.

Sternly forbid lady passengers to place parcels in the folds of the hood when furled.

Overhaul the joints of the framework for any unpinned nuts. Most hoods embody several unsecured nuts, which are very liable to jar off, and their loss may render the entire hood useless. Either carry spares or split pins or fastnut washers.

Protecting Varnish and Bright Parts.

332 Paraffin should never be relied upon to protect polished metal surfaces against rust. Although excellent as a rust reducer, it does not prevent oxidisation—indeed, it rather provokes it when left in contact with a metal surface. It is therefore a mistake to rub bright metal over with paraffin; vaseline alone should be used for this purpose. To protect bright copper or brass surfaces against the weather it is necessary to coat them with a quick-drying transparent varnish, similar to that used for the preservation of process blocks. Such protective varnishes are sold, but if not readily obtainable, a serviceable one can be made by dissolving a little resin in rectified spirit, and filtering the solution through a plug of cotton-wool, which will deprive it of any excess of resin. This varnish should be applied as thinly and evenly as possible, for it dries almost immediately. When desired, the thin transparent coating of varnish is easily removed by rubbing the surface with a soft rag dipped in methylated spirit.

After Varnishing.

333 We would advise those who are taking delivery of new cars, or old ones which have been done up, to test the varnish for dryness by pressing the thumb hard up against some unexposed portion of the body; pressure should be put on the varnish for several seconds, until the heat from the thumb is transferred to the paint. If the thumb comes away from the varnish without any feeling of stickiness, it may be taken to be perfectly dry, but any tendency to stickiness denotes that the varnish is not set, and should, if possible, be given several days more in which to dry. Any dust or dirt which comes in contact with imperfectly set varnish dulls, if it does not spot, the finish.

A Good Anti-vibrator.

334 The usual rubber mat fitted to the floor of motor cars does not possess a large amount of elasticity or ability to eliminate the vibration resulting from the working of machinery and from contact with the road. As is well known, most floor mats are made of some composition which possesses very small resiliency, and which is extremely heavy. We have found that if an ordinary door mat is fitted to the bottom of the vehicle this almost entirely removes vibration; it is also warmer to the feet, and is very easily cleansed from road dirt by the simple process of shaking, as is usual with ordinary door mats; and, furthermore, when going a long journey in the car, the vibration to the feet is very much less than when rubber mats are fitted—in fact, one could practically sit all day in a car without experiencing discomfort. It is well known that with the ordinary rubber mats fitted such is not the case, so that we can confidently give this tip to those who are exceedingly sensitive to vibration. Possibly, also, even if the mat were fitted to suit the floorboard, it would be found to be less expensive than rubber.

Draining Undershields.

335 If there are large drain or scupper holes in the undershield there will never be any accumulation of grease or oil. There is no great danger in such an accumulation; the danger is in the leakage of petrol. If the carburetter floods, or petrol by any means runs into the undershield, it cannot run out; and if the petrol catches fire, there is the accumulation of oil and grease to feed the flames. However, the point is this, that if there are drain holes, the grease cannot collect, and any petrol which escapes will instantly run out. The absence of such scuppers has resulted in the total destruction by fire of several cars. If the undershields had been well drained there would only have been a small fire, which would have been very easily stopped and quite short lived—nothing more than could be smothered with a rug.

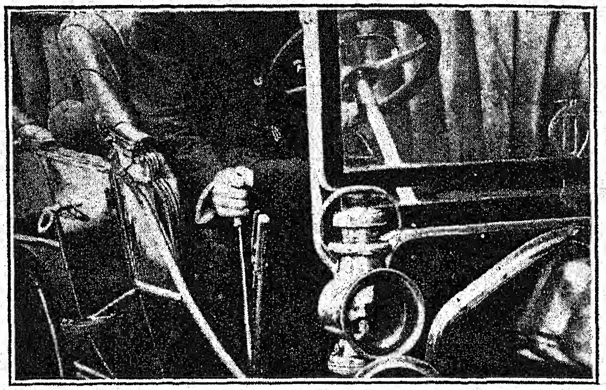
DRIVING.

Driving Hints.—What is Skilful Driving?—Pulling into the Kerb.—How to Cross Freshly Laid Stones.—Driving over Tar.—To See Well at Night.—Side-slip: Its Cause and Prevention.—To Avoid Side-slip on Ice-bound Hills.—Driving and Tyres.—Driving Home on the Rim.—Driving on the Brake.—Braking.—The Descent of Steep Hills.—Turning Corners.—Slipping the Clutch when Hill-climbing.—To Haul a Car.—Petrol Leakage: Lamp Dangers.—Tapping.—Safe Starting of Kicking Engines.—Quiet Starting.—Starting on the Switch.—Diagnosing Causes of Stoppages.—Contributory Causes to Loss of Power.—How to get the Best Work out of a Motor.—To Save being Dazzled.—Attention to Tyre Valve and Bolt Nuts.—Danger of Spoking Back Wheels.—How to Keep Spectacles Dry in Rain and Mist.—A Wet Weather Tip for Open Cars.

Driving Hints.

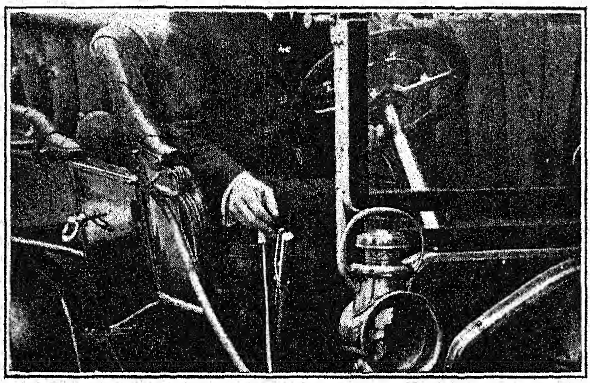
336 The mere matter of driving a motor car in the sense of getting it to a given point and back again without serious *contretemps* is a comparatively easy and simple accomplishment, even to a beginner, after a little practice, but, as in many of the details of golf—the grip, the swing, the stance, etc.—there is a right and wrong way, an easy and an awkward way, and sometimes a safe and a dangerous way of carrying out a number of the necessary operations. In order to exemplify the alternative methods in a few of these operations, I have "posed" before that fearsome individual, a photographer, and the results of our united efforts are shown in the accompanying reproductions.

Take No. 1. Notice the "fierceness" with which the gear lever is being gripped preparatory to making a change. This, to my mind, is a fault, and one from which a great number of drivers suffer, for unless there is some defect in the mechanism actuated by the movement of the lever, making the latter excessively stiff to operate, such a fierce grip is not only unnecessary, but a distinct disadvantage, for it tends to encourage undue roughness and force in changing, and thereby the teeth of the gears suffer. Why not hold the lever, for a forward



No. 1.—A fierce grip on the change speed lever—a bad method.

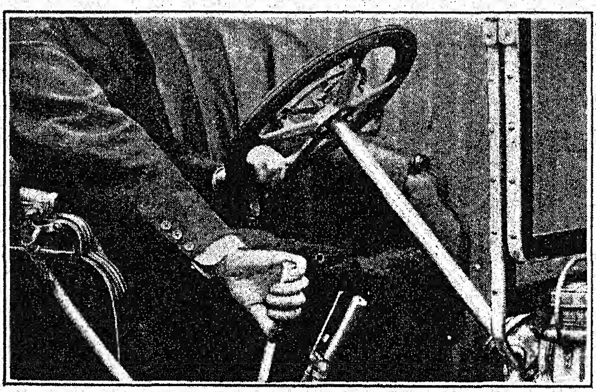
movement, or for forward and across the gate, as shown in No. 2? This method gives all the grip and certainty of movement that is required, and there is no implied necessity for great force as with No. 1.



No. 2.—The proper hold for a forward movement.

Illustration No. 3 can be taken to represent either the finish of the forward movement when the lever is held as shown in No. 2, or the "grip" before commencing a rearward movement. In the former case the action of "chang-

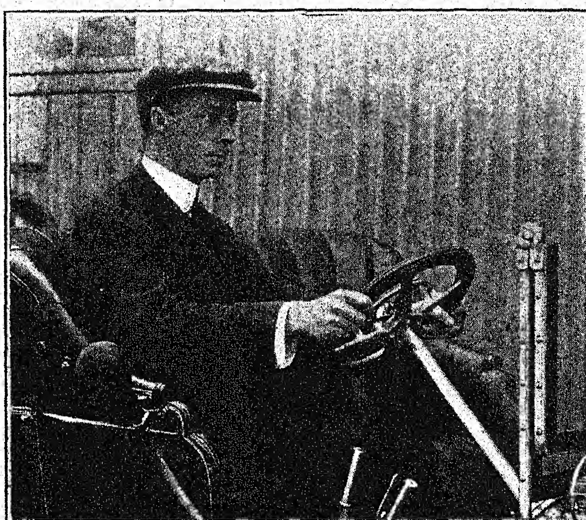
No. 3.—The finish of a forward movement, or ready for a backward pull.



No. 4.—An alternative grip particularly suitable for some gears.

ing " has been an easy natural operation ; no movement of the wrist has been required, the V formed between the thumb and first finger merely turning slightly round the top of the lever.

But imagine this same photograph to represent the grip for a rearward movement ; no more force is required than can be transmitted by the two fingers as shown. By holding the lever with the two fingers thus, firmly, of course, the action to revert to the position of No. 2 is far more easy and natural than if the fierce grip shown in No. 1 be again used.



No. 5.—A comfortable hold on the steering wheel but one having its disadvantages.

Illustration No. 4 shows an alternative method of holding the lever for a movement back and outwardly across the gate. I have found some advantage accrue from this method when the sliding shaft of the lever is liable to bind in crossing the gate. A number of cars are far from perfect in this respect, and the benefit of this grip is due to the fact that the natural pressure of the wrist and arm is then directed outwardly. I have noticed that the tendency to bind in crossing the gate is more often felt to a greater extent in passing from the inner side to the outer, and in such cases I can recommend this method of holding the lever.

Nos. 5 and 6 show two ways of holding the steering wheel, and, apart from the position as shown in No. 6 looking and feeling, to my way of thinking, far more natural and comfortable, it has the advantage—demonstrated in No. 3—that in reaching to the gear lever, when the latter is in its most forward position, there is no tendency for the movement of the body to cause a pressure of the hand on the wheel which might turn the latter at all.

No. 6.—A better hold on the wheel, and a more comfortable position.

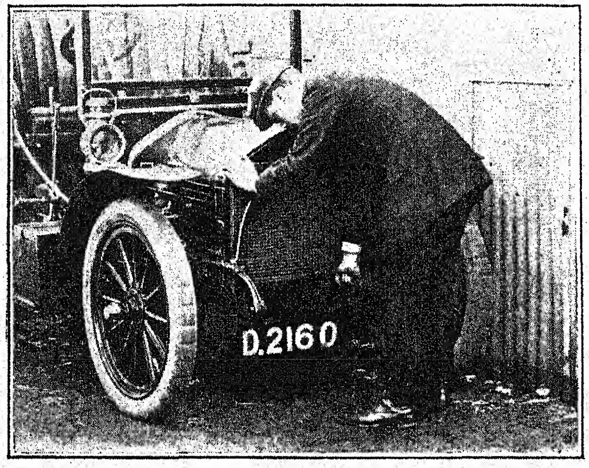
In making the change of gear mentioned with the wheel held as in No. 5, there is undoubtedly some liability that an unintentional movement of the wheel will be made away from the body on the left side. This especially applies in the novitiate stages of driving, when the required restraint to prevent any movement of the wheel in changing is often overlooked during the operation.

Personally, too, I find that with the left hand held at the bottom or in the centre of the wheel, as shown in No. 6, steering is accomplished to a nicer degree of accuracy and

precision in making small deviations from the straight line, and simply by a small movement of the wrist, which is all that is then necessary.

Nos. 7 and 8 have relation to what, I admit, is an old theme in connection with starting the engine, but I hope the illustrations will emphasise the point and enable me to add one or two remarks on the subject.

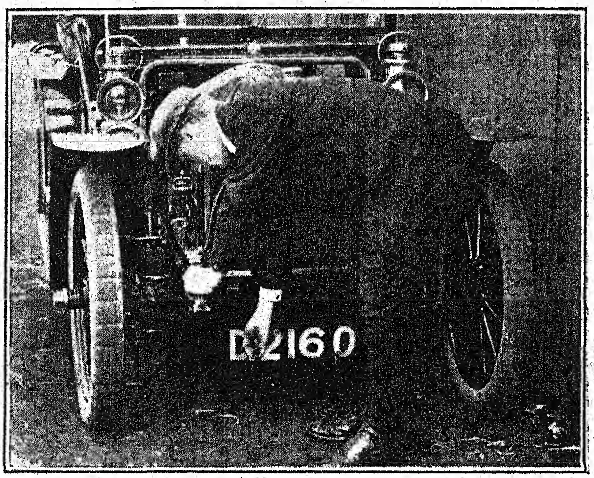
No. 7 shows the—well, not fatal, but greatly-to-be-deprecated method of commencing with a downward push stroke in starting. The probably dire results to the wrist in



No. 7.—Avoid starting an engine this way.

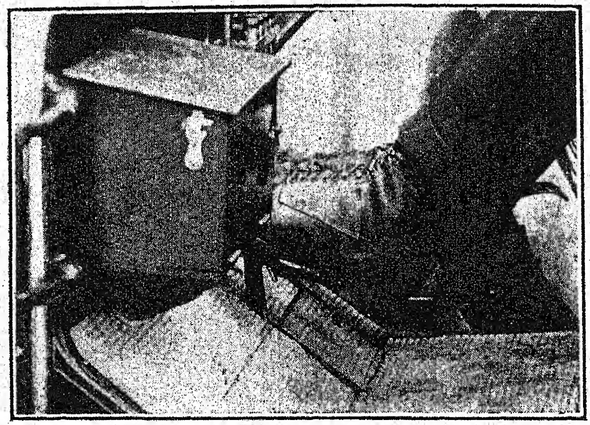
the event of a backfire are very apparent, but there is another danger in the operation when, as is very often the case, a position is taken up as shown. That is to say, by almost directly facing the car in this manner it will be necessary to bend the knees in the course of making a complete revolution of the handle. This naturally, when the knees are bent, brings one or both of them into the path of the handle, and if a backfire occurs then—which would be when the handle is in the opposite position to that shown, *i.e.*, as in No. 8—the chances are a broken or damaged kneecap will result by reason of a violent blow from the backward movement of the handle.

Far better and easier is it to take up a position as shown in No. 8, where the right-hand side of the body is directly towards the car, the left-hand resting on the dumb-iron and using the latter as a "steady" and a point from which some leverage can be obtained. In making a complete revolution of the handle, if the knees are bent to any extent at all, they are in any case and all the time quite outside the path of the handle in the event of a backfire and in the natural course of the swing. And last, but not least, No. 8 shows the correct and safe method of commencing the swing with a pull-up stroke



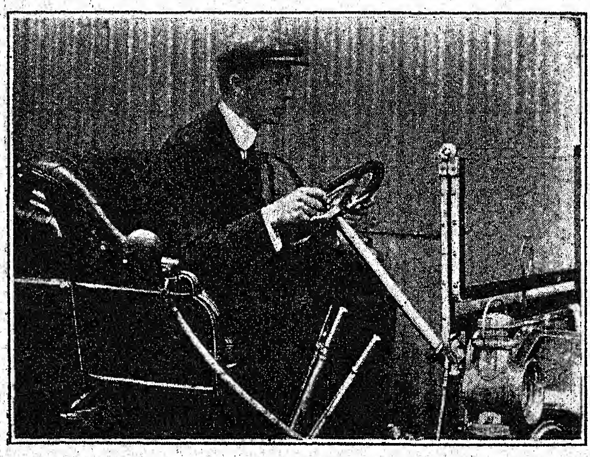
No. 8.—A better and safer starting position.

The position of the feet as shown in No. 9 is not to be recommended when the clutch is "in" and the brake "off." The heels, if not the whole of the foot, should be kept firmly on the floorboard, for by resting the weight of the foot on the clutch pedal as shown, a large amount of unnecessary friction and wear takes place at the clutch fork. Not only so, but by reason of the pressure thus exerted against the clutch spring, there is a decided liability that unless the power of the latter is considerably in excess of what is necessary, the clutch may sooner or later commence to slip. I may say on this point that I have more than once noticed when



No. 9.—A bad position for operating the pedals.

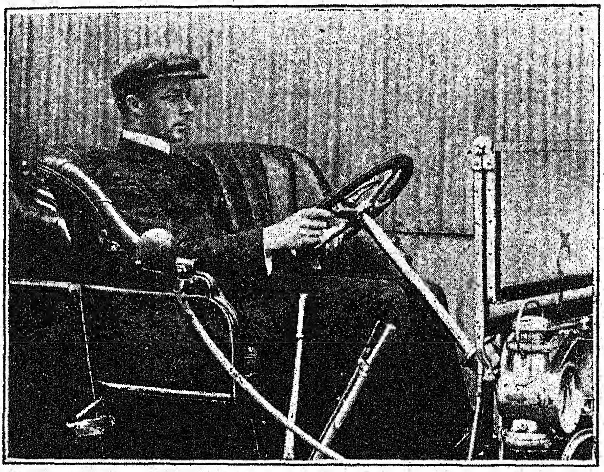
riding as a passenger on a car in traffic or through a town that the driver—not a man of very lengthy experience, perhaps, but then these remarks are not particularly addressed to "old stagers"—has unconsciously caused the clutch to



No. 10.—The nervous uncomfortable position of the amateur.

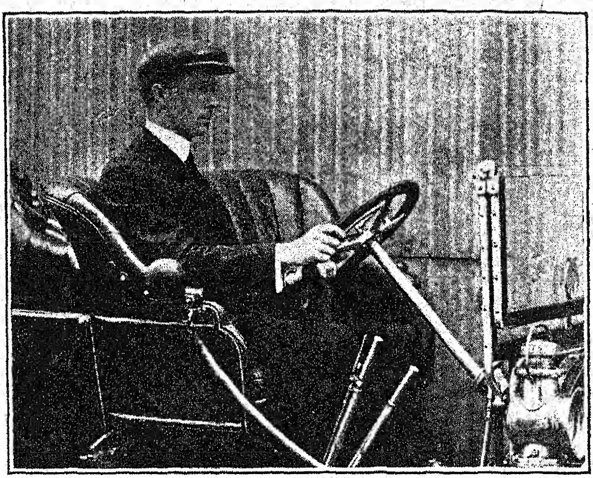
slip for considerable periods, merely by exerting a very slight pressure on the pedal, quite unintentionally, in addition to the weight of the foot and leg.

Nos. 10, 11, and 12 almost speak for themselves, and my only object in reproducing them is to decry the extreme positions or "seats" shown in Nos. 10 and 11. The awkward, apparently nervous, and uncomfortable seat of the former is frequently adopted by beginners. There is no additional safety or precision in the various operations to be obtained by leaning forward in this way—in fact, the "easy seat," as shown in No. 12, decidedly adds to certainty of movement, in steering or depressing the clutch, for instance.



No. 11.—The inelegant position which has been christened "the chauffeur's lounge."

As for No. 11, the "inelegant seat," which has been called the "chauffeur's lounge," but which, I am sorry to notice, is sometimes adopted by others—well, don't cultivate it; it's not pretty nor clever, neither is it comfortable. As regards the latter point I know that I was most uncomfortable when posing for the photograph, and quite thought I had rather exaggerated the position. I see now that I did not go far enough really to form a decidedly striking "dreadful example," but it proves to me that this lounging pose is not



No. 12.—An easy and comfortable seat ready for all emergencies.

assumed for reasons of comfort or ease, but, I suppose, because those who adopt it imagine that it looks sporting, clever, or something of the kind. This is not a place to express a too emphatic, even if honest, opinion of this attitude in driving and its exponents, but I would say to the latter, surely you can have no idea how—well, " rotten " it looks, even if you realise how uncomfortable it is.—MARCUS W. BOURDON.

What is Skilful Driving?

337 What do we mean, or what should we mean, when we say that a man is a " clever driver " ? My idea is, a man who so manipulates the car which he has under his control as to cause the least possible anxiety to his passengers, the least inconvenience to other users of the road, and the smallest amount of wear to the integral parts of his car, in addition to possessing and utilising a dexterity and knack in the carrying out of the various necessary and usual operations, such as steering, gear changing, etc. I do not consider that the individual who exhibits even a marked ability in these usual operations, without considering the first-mentioned points, is a skilful driver.

Considerate Driving.

It may be asked why I include consideration for passengers and other users of the road in the essentials of skilful driving. Well, it is generally admitted that for anyone to be proficient or skilful or clever at any work or pastime, he should exhibit a thorough knowledge of *all* the details in that connection, not merely specialising skill in the indispensable elements. And surely the comfort and nerves of the passengers are details which should be taken into account in the driving of a car. Why should not the ability to produce confidence and ease on his part be judged as an essential to be attained before the title " skilful driver " is merited ? There are some individuals who cause their passengers to be in a state of apprehension at every corner, vehicle, or obstacle which is encountered ; this surely denotes incompetent driving.

Regarding inconsideration to other users of the road, this is often, I think, to be accounted for by a lack of knowledge on the part of the driver of the rules and courtesies of the road. If I am correct in so thinking, then there is necessarily ignorance in this direction, and, as I have shown, to be denominated skilful, every detail must be considered.

There are some drivers—and I am sorry to be compelled to include amateurs as well as professionals—who, whilst they hold the steering wheel, cease to be or act as gentlemen, and this cessation may be due to want of knowledge or not. I am not addressing these in particular, but wish also to include in the following remarks those who, whilst they drive in a considerate manner to the best of their ability, do not reflect on the result of their actions in matters which I admit are details, but which, by pedestrians and cyclists, are magnified into grievances when looked at from their point of view.

Sounding the Horn.

One of these matters has to do with the use of the horn. At corners, do not " hoot, hoot, hoot," as though you expected everybody to clear the road for your coming—you may not so expect, but do not let it even appear that you are anticipating this—but give a warning blast or two if you like, and then drive as though you expected to meet a vehicle coming in the opposite direction. A hint to novices, by the way. If you approach an unexpected corner, and think that you have not time to use both the horn and the throttle, or when you are overtaking or passing another vehicle, use the throttle *first*. If you do the reverse, you will perhaps imagine that it is necessary to continue to give warning, and, neglect-

ing to slow down yourself, take the corner or pass the vehicle at a higher speed than is really safe when your inexperience is considered.

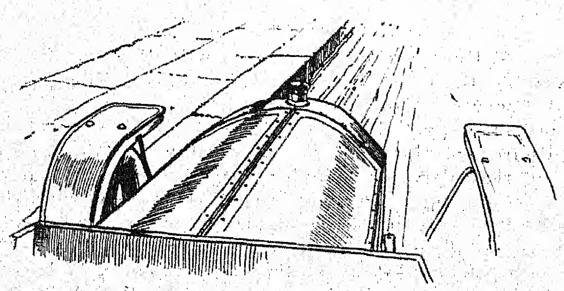
I am of the opinion that an excessive use of the horn denotes either one of two things—nervousness or selfishness. The driver is either fearful of the result of his own actions, or so inconsiderate as to expect others to clear the way without any slackening of speed on his part to help the desired effect. There are exceptions to this, of course—the sleepy waggoner, the tilt-covered van, for instance—but as a rule a polite warning is all that is required.

PASSING CYCLISTS.

Many motorists have not experienced the helpless feeling which possesses a cyclist when being overtaken by a car which allows perhaps 2ft. or 3ft. clearance in passing. This feeling of helplessness is not occasioned by want of confidence in the ability of the driver of the car, but by an uncertainty on the part of the cyclist regarding his own ability to keep a straight path. Do not think by showing how closely or correctly you can steer that you will engender confidence, but give as much clear space as you can. Bear in mind that you would have to face an unhappy time if the cyclist swerved and an inquest or an action for damages ensued. The skilful driver allows for deviations by the cyclist; he has knowledge of the uncertainties of the road unpossessed by the unskilled driver.—MARCUS W. BOURDON.

Pulling into the Kerb.

338 We have often noticed that careful motorists are the worst hands at bringing a car close to the kerb without touching it. Because they are careful, they are



¶ Sketch showing the visual position of the wing in relation to the kerb when the near side wheel is 3in. from the latter. The sketch was made sitting in the driver's seat.

determined not to run the risk of straining the wheels, axles, or steering connections by touching the kerb, and, in consequence, they more often than not err the other way, and instead of bringing the car within, say, 2in. or 3in. of the kerb, they pull up 1ft. or more away from it, and possibly have to back and edge in a bit closer.

While we would always rather see a driver keep well away from the kerb than touch it, even with a mere "kiss," the happy medium is, of course, better, and it is quite easy to strike it by taking a little trouble. Owing to the height and width of the wings in relation to the front wheels, it is often difficult to tell just where the wheels are when one is seated in the driving seat and pulling up towards the near-side kerb. Obviously, it is easy enough when pulling up against the off-side kerb.

All that is necessary to enable a near-side kerb—where, of course, the majority of stops are made—to be approached in the desired manner is for the driver to make an experiment or two. First of all, he should drive up to the side of the pavement in a quiet street, noticing carefully the line of sight from the eye to the kerb. As the driver is on the right-hand side of the car and the kerb on the left, the left wing will apparently overlap the kerb considerably, when, as a matter of fact, the wheel may be actually 10in. or 12in. from it. It is therefore only necessary to note very carefully exactly how much the left wing overlaps the pavement when the wheel is within 3in. of the kerb. If the car be placed in this position, and really careful observation taken of the apparent overlap of the wing on to the pavement, there will be no longer any difficulty about judging the position of the invisible wheel in relation to the kerb. The sketch reproduced herewith shows the actual amount of wing overlap noticed from the driver's seat of the car upon which the sketch was made, the wheel then being 3in. from the kerb. It is also useful to make a few experiments in the open country, as we believe that some drivers who do not "give way" to approaching traffic think they are as far over to the left as they dare go—when, as a matter of fact, they are from 18in. to 2ft. further out from their own side than they should be.

How to Cross Freshly Laid Stones.

339 In one of the French automobile papers the meritorious Michelin, having instituted an enquiry as to the most harmless way of driving a car over freshly laid patches of road metal, has summed up and presented the

replies received. The case is put from two points, according to whether the stretch of fresh metal is longer or shorter. In the case of a short stretch, and when a detour to avoid the stones is impossible, it appears to be the general opinion that the manner in which least harm can be done to tyres is to run declutched over the section at as low a speed as possible. That is to say, the driver should take the patch declutched sufficiently fast to land just clear of the stones on the other side. This requires some little judgment, for it is obviously highly undesirable to enclutch and deliver drive to the back wheels while still on the destructive surface. On the other hand, if the patch be of too great a length to be free-wheeled in the manner suggested, it is generally considered best to change down to first speed, and at that speed to pass over the stretch as slowly as possible. The driving impact is thereby greatly lessened, and the tyres are saved to the utmost possible degree.

Driving Over Tar.

340 Complaints are constant as to the damage done to the paint and varnish of cars which are driven over the tarred stretches before the tar has had time to dry. Not only so, but in many cases the dressing of fine gravel or chippings is either badly spread or very thinly spread. Indeed, in some cases nothing is thrown on the tar at all. Now, it is obvious that the only way to minimise tar splashes is to go very slowly, but even when this is done the chances are that in nine cases out of ten several nasty black spots will be found on the body panels, wings, and elsewhere, and the motorist is often surprised at this when he reflects how slowly he drove over the tarred surface, and he is almost inclined to think that he might just as well have run over the tar at a higher speed. As a matter of fact, this is not the case. The slower one goes over the tar the better, but we are firmly convinced, from observations we have made, that the harm is as often as not done immediately after the tar has been past, as the driver quickens up instantly. The treads of his tyres are covered with tar and grit, and this flies off at once owing to the speed of rotation of the road wheels. What should be done is not only to drive slowly over the tar, but to accelerate very gradually indeed after it is passed. If the car be kept dead slow after the treated stretch of road has been crossed the dust of the untarred road very soon absorbs the tar on the tyres, and it will drop away gently and without being thrown at the car.

To See Well at Night.

341 Not long since Mr. Frederic Coleman gave us a good tip in connection with night driving. He said he had been trying the difference between driving with acetylene head lights and the paraffin side lights in use simultaneously and with the paraffin side lights turned out, and he had found he could see much better without the side lights. Now, everyone knows that the side lights are quite useless from a driving point of view. They are all very well to use for a short time between the lights or for town work, but directly one gets into the country nothing is of any real use except a good pair of head lamps. At the same time, while the side lamps are no good so far as lighting up the road is concerned, they may baffle the driver and to some extent spoil his night eyes, as they throw a light upon the wings and the front of the bonnet, and this means that from the driving point of view the real driving light from the head lamps is to some extent discounted. We have tried Mr. Coleman's plan several times since he told us, and we have no hesitation whatever in stating that one can see better and further when driving at night with the head lights only than one can with the combination of head lights and side lights. To comply with the law one of the lights must be on the extreme right or off side of the car ; a centrally placed head light is not sufficient.

Side-slip : Its Cause and Prevention.

342 Speaking generally, there are two causes of side-slip. The first is due simply and solely to endeavouring to drive round a corner too fast, in which case the centrifugal effect tends to slide the car broadside off the road. The resistance to such sliding is determined by the adhesion between the tyres and the road, and when the road surfaces are extremely greasy, particularly under trees, the adhesion provided is not sufficient to maintain the car on its proper course at high speed. To drive without risk of side-slip one has, therefore, to slow down far more at bends and corners than is the case when the roads are dry or thoroughly wet. High speed at corners is the simplest cause of side-slip, and trouble of this nature may, of course, occur on a dry road if the corner be taken extremely fast.

Next to a dry road the best adhesion is provided by a surface which is thoroughly wet, a moist or drying surface being generally a greasy one, but in some limestone districts, such as Derbyshire or Somerset, the surface is always greasy

when it is wet, and in consequence great care must be exercised in taking corners.

The other cause of side-slip, which is not so generally understood, may present itself when the car is being driven perfectly straight ahead. As long as all four wheels roll freely over the ground, side-slip of this kind will not occur, but if the brake be applied hard, one (or both) of the rear wheels may be locked and will slip in a straight line. Immediately such straight line slipping takes place, the wheel in question loses its lateral grip, of the road, and can slide sideways. That this is true can be easily demonstrated by the following experiment: Place a loaded car on a wet grass slope with the engine stationary, and attempt to push the car sideways down the slope. It will be found that the car is im-

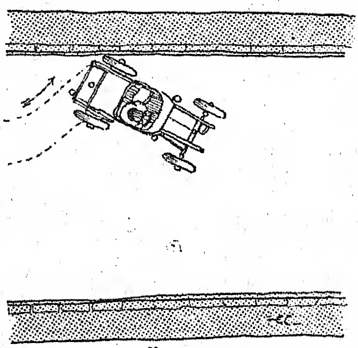


Fig. 1.

movable. Then run the engine and engage the first gear, locking the front wheels so that the car cannot travel forward, but allowing the rear wheels to spin. It will then be found that the rear of the car can easily be pushed sideways. This experiment is mentioned in detail to explain how easy it is to move the car laterally or towards the gutter when the road wheels spin. It teaches us that at no time must the wheels be allowed to rotate in relation to the ground when the surface is slippery. Otherwise, if the road be at all cambered, the car will slip down to the gutter. Such slipping can be stopped by causing this relative moment between the wheels and road to stop, either by slowing down the engine or taking out the clutch. Similarly, if either wheel be locked by means of the brake the car is liable to move laterally or skid. Such side-slipping can be arrested by releasing the brake.

It therefore follows that on greasy surfaces the brakes should be used gently, and the brake surfaces must not be allowed to become fierce. Also the clutch must not be engaged quickly nor the engine accelerated suddenly. With a powerful car on a greasy road it is possible, by merely opening the throttle two or three notches, to cause the back of the car to slide down towards the gutter. Closing the throttle to its original position allows the car to resume its normal course.

Fortunately, side-slip is generally confined to the rear wheels, though occasionally the front wheels slide when taking a corner too fast. Little can be done with a front wheel skid, and the only precaution is to slow down at bends or to use suitable non-skid treads.

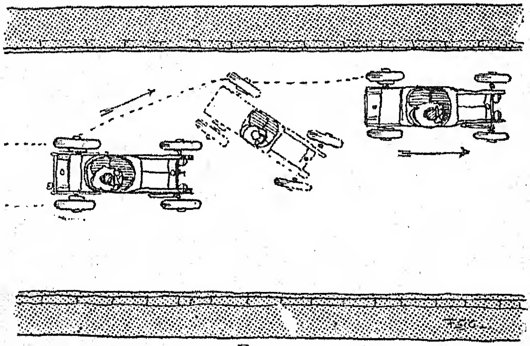


FIG. 2.

If the back wheel slides towards, say, the left hand, it is obvious that the front of the car will face the right-hand footpath. The first thing to do is to take out the clutch and release the brake, if it has been applied. This will stop the skidding and allow the car to travel in a straight line, which will be towards the right-hand path, as indicated in the sketch, fig. 1. The driver must consequently turn his steering wheel to the left, so as to bring the car into its proper line again, and when the car is perfectly straight the clutch can be let in gently. The beginner is rather apt, as soon as the car commences to slide, to apply his brakes, which simply accentuates the side-slip, and it must be remembered that the brakes should under no consideration be applied until the car is in its proper course again. The correcting of a side-slip by means of the steering wheel should be contemporaneous with the side-slipping of the rear of the car, with the result

that the car subsequently travels in a line parallel to its original path, as shown in fig. 2, this view also showing the original and intermediate positions of the car.

It may be well to mention one frequently recurring case where side-slip occurs. One is driving on a somewhat narrow and cambered road which may be perfectly straight, and when meeting a vehicle has to pull down towards the gutter. On turning the steering wheel to resume one's position towards the centre, or crown, of the road, a beginner is surprised to find that his car heads for the right-hand pavement, as shown in fig. 1. In such a case, he should, of course, immediately declutch and exaggerate his steering towards the left-hand side of the road, refraining from using the brakes. He will then regain a straight line, and, it is hoped, will have learnt an important lesson. That is, never to steer sharply from the gutter towards the crown of the road when the surface is wet or greasy. This applies to starting a car from rest as well as in the case mentioned. The cause is chiefly that the adhesion of the driving wheels is insufficient to overcome the centrifugal effect, whilst at the same time there is a slight tendency for the wheels to skid forwards, which, as stated previously, is in itself a cause of side-slip.

When pulling up at a kerb, it must be remembered that the car will skid towards the gutter if the road be greasy and the brakes applied suddenly at all hard. This may in many cases do no harm, but if the hood overhangs much and there is an adjacent lamp-post some damage may be done by a more or less serious collision.

Side-slip can be absolutely prevented, so long as no reckless driving is indulged in, by the use of non-skid devices, such as studded tyres, Parsons chains, etc., and it behoves the beginner to see that he is either safeguarded by means of such fitments or else capable of dealing with an occasional side-slip which may occur to him. The best course is to drive very slowly on greasy roads, not to accelerate quickly, and to apply the brakes gently.—ERIC W. WALFORD.

To Avoid Side-slip on Ice-bound Hills.

343 We have most of us had experience of driving on frozen roads, and the novice will find, or has probably already found, that extreme caution is necessary when descending winding hills. There is one practically safe method of descending without danger, and this applies, of course, to slippery roads of any kind. It merely consists of driving with the wheels at one side in the gutter. If one wheel is already

in the gutter, there is very little tendency for the car to slip out of it. Again, if the car is close to the pavement, a slip of an inch or two into the kerbstone is not much to worry about. As long as one stays in the gutter it is impossible for the car to turn round and go broadside down the hill. Further, in many cases roads are only frozen on the crown, and at the side and in the gutter there is pretty good holding.

Driving and Tyres.

344 Undoubtedly the largest item in the cost of running a car is that due to the upkeep of the pneumatic tyres. This item varies very largely with different drivers of cars, and a low bill for tyres is usually attributed to luck. Now, luck plays a very inconsiderable part in this respect; really and truly, one might say no part at all other than that of missing broken glass and horseshoe nails. The most serious damage which is done to tyres is that due to excessive speed, overloading, sudden letting-in of the clutch, misuse of the brakes, and driving over newly metalled roads with the full power of the engine operating at the road wheels. All of these are practically and solely entirely due to bad driving, and have nothing to do with inherent bad properties of the tyre. With the flexible throttle control, as fitted to modern cars, the necessity of constantly applying brakes vanishes, and if only reasonable care is exercised by a driver, almost the whole of the running can be done on the throttle; hence the brake need only be used on very severe hills and for pulling up at any place. Some clutches are much fiercer in action than others, but the knack of gently letting in the clutch can be acquired if intelligently practised, so that no snatch is transmitted from the engine to the road wheels. The sudden action of any clutch or brake simply causes lumps to be ripped from the tread of a tyre when on a rough road, thus the life is very considerably reduced.

Another point: Overloading the tyre. The buyer of a car should insist upon having tyres with an ample margin for the weight carried. The first cost may be a few pounds higher, but in the long run this is saved over and over again.

It should always be remembered that wet surfaces cut rubber much more readily than dry. In the case of small cuts on the tread, these should at once be filled with one of the special "tyre stop" preparations, or preferably vulcanised, to prevent them opening out or being further cut. If these remarks are digested, the tyre bill will be considerably lessened, apart from so-called luck.

Driving Home on the Rim.

345 It must occasionally fall to the lot of every motorist to find himself obliged to drive home on the rim—in other words, he is unable to keep any air in his tyre, he is without spares or too short of time to struggle with a refractory inner tube, and so elects to drive on and ignore the consequences. Common prudence will suggest a moderate speed, and if the distance to be traversed be short, the security bolts well tightened, and the road surface smooth, it is possible that little harm may be done. Supposing the cover to be badly burst, while the tube is in good condition bar the burst, it is a good plan to remove it and drive on the cover alone —its last drive most likely. If both cover and tube are in good order, and the deflation is due to a puncture or loose patch, it is well to screw the bolts up for all they are worth, and if the cause of puncture is to be found in the shape of a nail or boot tip, remove it. When putting things right in the privacy of your motor house you will doubtless find the leather heads of the security bolts badly crumpled; if they will straighten out so much the better, if not they can be made good with canvas. A most important point is to see that they are not bent out of shape as regards the plates which form the heads. These are in the form of a flat-bottomed _/, and the sides are very liable to spread under such treatment as I have suggested. If they are put back in such condition they fail to bed down into the rim, and in consequence the inner tube will be able to blow down under them, and give way at inconvenient times. Not that any time is convenient for tyre trouble, but some times are less inconvenient than others.—H. SCOTT RUSSELL.

Driving on the Brake.

346 It is very bad practice to drive on the brake, though some people who know no better think it showy. By driving on the brake we mean driving jerkily. For instance, we will assume that the driver is coming to a turn or overtaking a block in the traffic. Instead of reducing his speed gradually as soon as he sees the necessity for a slack or perhaps a stop, he rushes up to the point, and then jams on all his brakes and pulls his car up dead. The next moment, as the necessity for the slack has passed, he crowds on all available power without allowing his engine a moment to recover and introduce itself gradually to its car. This sort of thing ruins any engine and car, as it subjects them to extremely severe shocks and strains. In fact, there is no

doubt whatever that more than one mysterious failure has been caused by the parts being overstrained through this reprehensible manner of driving.

Braking.

347 The fact that there are two brakes to every car seems to have escaped the notice of many drivers, for in ninety-nine cases out of a hundred the hand brake is used solely as a sort of stand-by. The foot brake is always used, the hand brake rarely, with the result that the first is unduly worn, whilst the wheel drums are hardly ever called into play. Now, apart from the fact that this is not economy, it is very bad driving policy, in that the driver, never using his hand brake, does not cultivate the instinctive operative faculty, with the result that in cases of urgent need, thought is necessary before he can apply his "emergency" brake.

The Descent of Steep Hills.

348 Every car worthy of the name has brakes which will hold it upon any hill, however steep. At the same time, there are certain long and steep hills which should always be taken with the utmost caution, and upon which it is, as a rule, inadvisable to depend only upon the brakes. It does not matter how powerful or how even the brakes may be in action, they are necessarily the last resource, and they should not also be used as the first. If they are depended upon solely for checking the car, this does not matter greatly with water-cooled brakes, but the vast majority of cars have not water-cooled brakes, and if the hill turns out to be longer than was anticipated, the brakes may overheat. When a brake overheats it is a source of great danger, because it grips so violently that it is impossible to prevent the wheels locking at every seizure, and the shock is so great that there is every probability of the brake failing. The right way to tackle really dangerous hills is to use the brakes as a stand-by and the engine as the main check. On steep and not long hills, where only a moderate check is required, it is only necessary to close the throttle or switch off the ignition, but on really dangerous hills it is much safer to come down on one of the lower gears. As a rule there is no need to come down on the first speed, the second speed is low enough. It is desirable to stop, restart on the first, then put in the second. One simply drives carefully over the crest of the hill, then closes the throttle. If the throttle is set not to close absolutely, it is also desirable to switch off the ignition. It wil then be found that the car will run quietly down the hill,

and that, unless the hill is of exceptional steepness, the brakes will scarcely be required at all, except just to steady the car here and there at a bend or an exceptionally steep part. If it is found that the brakes are necessary, it is advisable to use the side brakes, and keep the pedal brake in reserve.

Turning Corners.

349 A valued correspondent, in dealing with accidents at corners, brings up a point which is worth special consideration. His contention is that if, in turning a corner, one finds a cyclist or a motorist bearing down upon one on his wrong side, one's natural inclination is to go over to the right to make room for the man who is apparently about to charge one. He is convinced, from observations he has made, that on the whole it is much safer to keep to the left, as if one once begins to go to the right, the oncoming rider or driver, though he may have been on his wrong side, when first seen, is in a dilemma, and a collision is almost unavoidable. On the other hand, by sticking firmly to one's proper course, the man on the wrong side has a very good chance of changing his direction and avoiding a collision by the simple expedient of going over to his own side. We know that arguments to the opposite effect can be introduced, but we think, considering all things, the safest thing to do is not only to be careful always to turn corners to the left at a reasonable speed, but having once done this, to keep to the left. It is much safer than cutting out to the right on the assumption that the man on his wrong side will keep on his wrong side. Stop if you can, but do not imagine that you can tell what the other man is going to do. It is far safer to assume that he will turn sharply over to his proper side than it is to assume that if you go on to your wrong side he will keep to his wrong side, and so pass without danger to either.

Slipping the Clutch when Hill-climbing.

350 Many drivers resort to the slipping of the clutch to enable the car to surmount a hill rather than change to a lower gear. There are many who advocate such a method of driving, while, on the other hand, there are those who deprecate it. Without doubt, it may be said that the practice is a bad one.

To Haul a Car.

351 In the event of a breakdown irremediable upon the road, when recourse must be made to haulage by another motor, or anything that can exert tractive force,

care should be taken as to the manner in which the tow rope is attached to the car. It is by no means advisable to make the tow rope fast to the front axle ; it is better to secure it to the projecting ends of the frame, which serve as spring horns, and pass the rope between these and the ends of the springs themselves. The haulage stress is then distributed evenly through the frame to both axles. The ends of the rope so passed should be taken and attached to any suitable part of the haulage equipment. If the car is to be loaded up on to a float or waggon, take care that the wheels of the float or waggon are securely blocked before any attempt is made to run the car up the inclined planks by which the floor of the waggon is to be gained. Be ready also with suitable blocks or rods to scotch the wheels of the motor, and arrest it at any part of the ascent if this should prove necessary from any cause whatever. Where a car has sustained such damage to one of the front wheels that it cannot travel on it, a strong pole may be passed under the front axle or the frame and fastened to the back axle. The front end of the pole can then be attached to the towing vehicle, so that the damaged wheel is raised just off the ground.

Petrol Leakage: Lamp Dangers.

352 If a leak in the petrol lamp or connections is discovered at night, the lamps should be put out at once, and care taken that no light is brought near the car. If it is impossible to rectify the leak without light, and no electric lamp or torch is available, the acetylene lamp may be lighted and placed at least four yards from the car. When the leak is stopped, the escaped petrol should be wiped away, and a few minutes should be spent in waiting for what is left to evaporate before attempting to light the lamps. If the leak of petrol has been great, the best plan is to push the car clear away from the spilled petrol before lighting the lamps.

Tapping.

353 Sometimes it will be noticed that the engine, which has been running perfectly well and easily, will begin to make a slight tapping sound. It is not sufficiently pronounced to be called a knock, and very often it will puzzle the driver to know what it is caused by, and in the majority of cases he will be apt to put it down to some slight peculiarity of his valves. As a matter of fact, it is nothing of the kind, but is due to very slight premature ignition. Of course, when an engine begins to labour with the ignition too far advanced,

there is no doubt whatever as to the cause; but the comparatively light tap caused by only very slight premature ignition is not usually recognised as the first symptom of too early firing. It will be found that it invariably occurs when some slight increase in resistance, either through an up grade or traffic slack, causes the engine speed to be momentarily reduced, and the retarding of the ignition by a notch or so will, on all cars provided with a moderately delicate ignition regulation, put the matter right at once. It also occurs through pre-ignition in the engine caused by the deposit of carbon on a piston head, which has become incandescent, and thus ignites the charge too soon. This may be caused by over-lubrication, or even by leaving the engine in gear with the ignition cut off when coasting down a long hill. Another cause of knocking is that due to looseness of the nuts on the bolts which fasten the cylinders to the crank chamber.

Safe Starting of Kicking Engines.

354 When attempting to start an engine fitted with magneto ignition of which the firing point is fixed, there is always the danger of a backfire happening and damaging the operator's arm. The reason is that when no arrangement is fitted for varying the time of ignition the magneto armature is fixed so that the spark takes place early—in fact, slightly forward of the end of the compression stroke. Consequently, if the starting handle be cranked slowly a backfire is obtained. This advanced position is necessary to enable the engine to run at high speeds. To start such an engine safely, the course to adopt is as follows: Put the switch to the "off" position, then swing the engine crankshaft round smartly for a few revolutions after the throttle has been opened and the carburetter float tickled. Then put the switch to the "on" position, and pull the starting handle up smartly over the firing centre.

Quiet Starting.

355 Although the tip we are about to give is well known to many, it would appear, from what we see and hear, that there are at least as many motorists who know it not. Some carburetters are so adjusted that, unless the throttle is opened fairly wide, the engine will not start. The result is that, after the usual cranking has been done, the engine starts off with a roar which, in some cases, is so loud and so sudden that it is quite startling to human beings, not to mention horses. The moment the engine starts the driver rushes from the starting handle to the throttle to close it

down, and so stop the noise and the "racing." Now all this commotion and fuss can be stopped in nine cases out of ten by the following simple procedure: Open the throttle as wide as the engine requires it for starting, but to leave the ignition "off." Then turn the engine over quickly a few times, return to the throttle and close it to such a position that the engine will run quietly, switch on, and return to the starting handle, giving it one sharp pull up. The engine will then start quietly and without racing. Of course, the same procedure holds good when a "press button" starter is used, but in this case there is no need to make the second trip to the starting handle. It is a fact that the wide-open throttle is only required when the engine is being turned by hand, but is not necessary when ignition takes effect, and causes the engine to run at perhaps only a slightly higher speed than can be attained by manual effort.

Starting on the Switch.

356 Now that so many cars are fitted either with accumulator ignition as a stand-by, or with the Bosch or other magneto dual systems, a hint as to how to ensure starting on the switch as a practical certainty may be welcome. Many cars fitted with modern automatic carburetters fail to restart after about five minutes, owing to the carburetter receiving too much air, due to careful tuning for economy. To make switch-starting a certainty, as rich a mixture as possible should be drawn into the cylinders, and to ensure this a shutter or throttle should be fitted to the fixed air intake, which should be closed immediately before stopping the engine. A good alternative is to adjust the carburetter rather more on the strong side, and then fit a controllable extra air valve, which can be opened when clear of traffic and closed just before switching off.

Diagnosing Causes of Stoppages.

357 When an engine stops work, and the owner diagnoses, or believes he diagnoses, the reason, it is well to test that diagnosis first before going on to anything else, for if, say, he cleans and tests his sparking plugs, inspects and tests the valves, agitates the carburetter, varies air feed, and fills up the petrol tank all before he restarts the engine, he is then quite innocent of the real stopping reason, and has not advanced in knowledge. Whereas if the inducements to restart are tested one by one, he discovers what was really the cause of failure, and is far more likely to recognise it at once should it exercise its baleful influence at any future time.

Contributory Causes to Loss of Power.

358 From time to time one comes across motors of which their owners complain that, while they do very well on the level, they just behave scandalously when a hill of any gravity presents itself before them. Making a general and cursory test, it is found that the compression in each cylinder is good, the ignition apparently satisfactory, the timing correct, the operation of the valves visually good—in fact, there seems nothing emphatically responsible for the sluggishness of which the owner complains. Now, there is only one thing to do in such a case and that one comprises many. It is to go carefully and minutely through the motor, and though it will not be found that any one detail is radically at fault, yet it is more than probable that one or more sparking plugs are dirty or have spark gaps too large, the electrical connections are somewhere loose and dirty, there is a slight short somewhere, there is deposit in the carburetter, or the gauze filters at the bottom of the tank or in the union close to the float feed chamber are more or less choked, an exhaust spring is weak and its valve does not close as smartly as it should, the holes in the silencer are choked with mud or grease and there is some back pressure caused thereby, one of the brakes is rubbing more or less on its drum, a pneumatic tyre is soft, the accumulators are down a bit, or there is a considerable deposit of carbon on the combustion chamber walls and piston heads. These small matters taken separately do not appear to be particularly serious, and should not of themselves detract in any marked degree from the pulling power of the engine. Let us suppose, however, that each of these little failings reduces the horse-power by one-tenth. It will easily be seen that their sum total of reduction is enough, and more than enough, just to deprive the engine of that vim without the sentiency of which no true automobilist is really happy at the wheel. This sluggishness is generally found a characteristic of careless owners. Those who desire to get the best out of their engines and cars, under the best conditions, should give periodical attention to all the little points to which we have referred.

How to get the Best Work out of a Motor.

359 Here are three good fundamental rules for getting the best work with the least consumption out of your engine: (1) Drive with ignition advanced to the utmost short of getting engine knock. (2) Admit as much air to the carburetter as possible short of getting misfires. This, of

course, only obtains with carburetters in which the air supply is controllable. (3) Never let the engine run hot or in want of the proper supply of lubricating oil.

To Save being Dazzled.

360 It is always advisable to have ready a pair of tinted or smoked glasses or goggles, so as to be prepared for driving against a low sun. In the early morning, and frequently in the evening, when one is driving facing a low sun, it is almost impossible to see. If a pair of smoked glasses are available there is no difficulty. Of course the trouble only occurs when it happens, as it does occasionally, that one is driving almost directly against the sun.

Attention to Tyre Valve and Bolt Nuts.

361 The air tube valve nut, and also the securing bolt nuts, should be carefully gone over periodically to feel whether they have worked slack. With the running on the road this frequently happens, so that it is a good plan to try all of these with a small pair of pliers, as the thumb and finger grip on these is not sufficient to tighten them up satisfactorily. If the bolt nuts are allowed to get slack, there is a great tendency to shear the bolts or deform their heads. The latter tend also to tip up, and the result is that the inner tube gets nipped beneath the head, and in a very short time bursts, thus causing serious trouble on the road, but the pliers must be used very lightly.

Danger of Spoking Back Wheels.

362 Sometimes when a car has been drawn on to the grass at the side of the road for a stop to admire the scenery or to have lunch or tea, it will be found that if the grass is very soddened the wheels will not bite, and the more the driver tries to get a start the more the wheels fly round. If there are two or three passengers it is quite easy to get a start by the assistance of a couple of them, who only have to give the car a good hearty push. However, a good many occasional motorists—that is, people who do not own cars, but who do more or less motoring in friends' cars—know that the easiest way to move a car is to take hold of the spokes of the wheel. Quite recently, when accompanied by two friends, we found ourselves unable to get sufficient adhesion on some wet grass to make a restart, and our two muscular companions at once rushed to the wheels, one to one of the front wheels, which was all right, and the other to one of the back wheels. Luckily we saw what he was about.

If we had let in the clutch he would most certainly have been hurt, as the wheel would have spun round and thrown him to the ground, and perhaps have broken a bone as well. We mention the matter because one's assistants in a case of this sort do not necessarily realise what is taking place. They are sitting in the car and do not know that the wheels are spinning round, so that it always behoves one to watch carefully to see that they either push the car by the dumb-iron, or if they take hold of the spokes, that they attack the front spokes only.

How to Keep Spectacles Dry in Rain and Mist.

363 To keep the glasses dry, three essentials appear to be necessary: (1) A glass screen through which the motorist can see when sitting easily, but over which he can just manage to look by sitting very upright. (2) A spare cushion from 2in. to 3in. thick. (3) A hood with an extension forward and sufficiently low to come almost down to the driver's horizontal line of vision when he is seated upon the extra cushion.

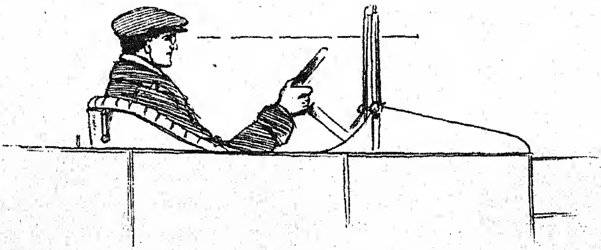


FIG. 1.—Driving on a dry day and looking through the screen.

Fig. 1 shows a spectacled driver seated on the ordinary single cushion. It will be seen that in this position he looks through the screen, which comes slightly above the level of his glasses. We will assume that rain or mist comes on. The motorist will then find that he cannot see through the screen. Not only so, but his glasses will get quite wet from the rain or mist which comes between the hood and the screen. However, if he takes an extra cushion, or in lieu of that folds up a rug so as to bring himself about 3in. higher, he will then be able to look over the top of the screen, and his head will be sufficiently high into the hood to protect his glasses from rain or mist. Fig. 2 shows the same car, screen, hood, and driver. Nothing is altered from fig. 1 except that the spectacled driver

is sitting upon a second cushion, which raises him nearly 3in. higher than his normal position in fig. 1. In this higher position he can drive in heavy rain without the glasses becoming obscured. It might be better still if the hood projected another 3in. or 4in. forward and came 2in. lower, but the arrangement shown was found so satisfactory that it was not considered worth while to alter it.

It might be urged that an equally good result could be obtained by having a screen which was adjustable vertically, so that when rain came on it could be put down 2in. or 3in., so that the spectacled driver could look over it; but this is not the case, as his head is not sufficiently high up in the

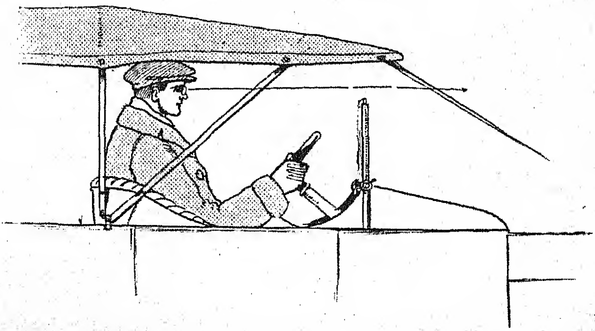


FIG. 2.—The spectacled driver on a wet day seated on an extra cushion and looking over the screen and under the hood extension.

hood for his glasses to be protected from wet. From fig. 2 it will be seen, if a horizontal line is drawn from the glasses of the driver straight out over the screen and under the hood, that the edge of the hood is still well above the driver's glasses, and it would be imagined that they would get wet in consequence of this, but in practice this does not happen.

A Wet Weather Tip for Open Cars.

364 If whilst driving you find yourself seated in a pool of water, seize the first opportunity to vacate the car, and insert several folded newspapers within your garments next to the skin. The method is also applicable to other cases of getting wet. After inserting the papers you may cautiously dry your clothes by standing in front of a fire. Care should be taken, however, that the water vapour does not penetrate to the skin and render the inner layers of paper damp; if it does, remove the paper.—W. H. GLASER.

GEAR CHANGING.

INTRODUCTION.—FROM NEUTRAL TO FIRST SPEED.—CHANGING UP.—CHANGING DOWN.—ANOTHER METHOD OF CHANGING DOWN.—CHANGING DOWN IN TRAFFIC.—ENGAGING THE REVERSE.—GEAR CHANGING IN A NUTSHELL.

Introduction.

365 A regular contributor to *The Autocar* ("Runabout") once referred to the very apparent dread of changing gear possessed by many drivers, and mentioned instances within his knowledge of gear pinions having been worn out in remarkably short spaces of time by reason of the drivers' lack of skill in the operation of changing gear. Undoubtedly there exists a great deal of want of skill in this respect, and every day one encounters instances of incorrect and haphazard manipulation of the gear lever and clutch.

In the handling of any one of the vast majority of the cars at present running on the roads, there are ways and means of changing gear without any noticeable sound, and without the slightest shock or jar; but it is certain that, unless the driver possesses a foreknowledge of what occurs within and without the gear box at the moment of changing, he will not, unless by good fortune, make the change satisfactorily.

The changing of gear on some cars presents greater difficulties than on others. This is admitted, and on one or two well-known cars the design of the gear box renders it impossible to change from direct to indirect gear without making a certain amount of noise, but in nearly all cases any change can be made noiselessly after a little practice if only a prearranged system be decided upon. The system, or theory, on which the practice is based must take into account all the varying conditions to be met with, but—unfortunately for their own peace of mind, the nerves of their passengers, and the well-being of the gear pinions of their cars—many drivers apparently have neither system nor knowledge on which to found a practice which will give satisfaction when followed out.

The following notes and advice on the subject are the outcome of driving experience gained with more makes and types of cars than the writer cares to enumerate; and while the system recommended in the matter of "changing down"

—the operation which forms the stumbling block for the majority of drivers—has been called into use in all cases, the number of cars upon which the practice has failed to ensure a quiet change is negligible.

From Neutral to First Speed.

366 Before dealing with the actual *changing* of gear, which, of course, implies that a pair of pinions, or the dog clutches forming the direct drive, are in mesh when the gear lever is moved, it will not be amiss to refer to the operation essential to moving the car from rest, namely, the movement of the lever from neutral to a forward speed or into reverse. Referring to the diagram on next page which shows the various parts of a three-speed gear box, the clutch within the flywheel, and the coupling shaft, it will easily be realised that, with the engine running and the car stationary, the following conditions prevail:

(*a*) The clutch and intermediate or clutchshaft are rotating at the same speed as the engine, while the layshaft or secondary-shaft and gear wheels attached to the latter are rotating in accordance with the ratio of the constant mesh gearing.

(*g*) The primary-shaft and its gear wheels are stationary.

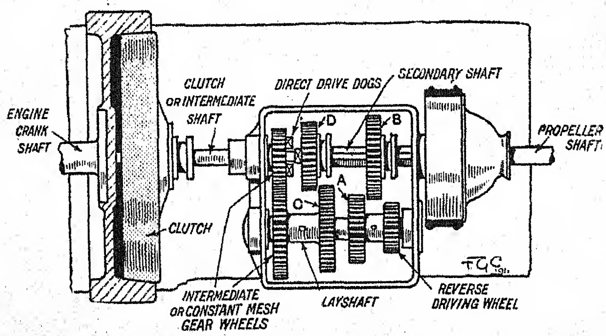
This being the case, it follows that a noise will ensue if the gear lever be moved towards the engagement of first speed immediately upon the clutch pedal being depressed, owing to the rotating pinion A being pressed against the stationary pinion B. To ensure a noiseless engagement of the first speed both pinions must be stationary, and this will not occur until the clutch, intermediate-shaft, and layshaft have all come to rest. This state of things will naturally ensue within two or three seconds after the clutch has been disengaged if the pedal be depressed to its full extent, and then the first speed may be engaged without the slightest noise.

Instead of waiting for the intermediate-shaft and layshaft to come to rest, many drivers, probably the majority, simultaneously with the depression of the clutch pedal, force the gear lever into its first speed position, causing much noise and jarring of teeth, and probably a jerk forward on the part of the whole car.

Some cars are fitted with a more or less efficient clutch stop, or clutch brake, as it is sometimes termed; and with such cars the period of hesitancy necessary between the depression of the pedal and the movement of the lever is more or

less decreased. To determine the minimum pause in any given instance should not be a difficult matter.

It is sometimes remarked when the above advice is given, "Oh, but I find that if I allow the clutch to stop revolving in that way I cannot engage the first speed at all." This is quite true in some cases, and the reason is that the faces of the teeth of the gear wheels, through wear, have become flat, *i.e.*, the chamfered edges have worn away, so that, unless the wheels come to rest with the teeth to be meshed exactly in the right line, the pressure of one against the other has no effect. The idea of the chamfered edges is to give a "lead" to the teeth in such circumstances.



Diagrammatic sketch of a three-speed gear box.

Another reason why difficulty is sometimes experienced in engaging the first speed from neutral when the pause is made is that not only is the clutch pedal depressed to its fullest extent, as it should be, but too great a pressure is exerted upon it, with the result that when a clutch stop is in position the shafts are practically locked. So that, although the chamfered edges of the gear pinions may be in perfect condition and the necessary "lead" available, no advantage accrues, as the wheels cannot be moved when they are pressed one against the other by the operation of the lever.

Therefore, if difficulty be found in engaging the first speed after pausing, as advised, do not press so strongly upon the clutch pedal as to lock the shaft; then probably no trouble will be experienced. If difficulty be still experienced, it may be taken for granted that the teeth are worn, as first suggested (or have not sufficient chamfer). In that case let the clutch in again a very little way, so that the internal friction of the

clutch bearings may, when the movement has been made sufficiently to render the "stop" inoperative, cause the clutchshaft to rotate slowly; the constant mesh gears will then rotate the layshaft, and the gears should engage with only the faintest indication of jarring or noise.

Changing Up.

367 Taking the change from first speed to second as an example, the following conditions prevail before changing:

(*a*) Engine, clutchshaft, and layshaft with pinions attached are running at a comparatively high number of revolutions per minute.

(*b*) Primary shaft revolving slowly.

The difference between the ratios of the first and second speed necessitates that either the speed of the primary shaft shall be increased or that of the layshaft reduced. Now we cannot speed up the primary because it is connected permanently to the road wheels; therefore, we must cause the speed of the layshaft to be decreased somewhat.

This diminution of speed is, by a number of drivers, brought about by forcing the second speed wheels C and D against one another immediately the clutch has been withdrawn, almost simultaneously with the depression of the clutch pedal. The noise that ensues, which is, of course, accompanied by unnecessary wear of the faces of the teeth each time it occurs, is only to be expected, but it can be entirely avoided if a somewhat similar practice be followed to that recommended in the case of the movement from neutral to first. The clutch pedal should be depressed to its *fullest extent*, so as to bring the stop into action, and the lever moved slowly but with decision from first to second. It will be realised that the retardation of the clutchshaft cannot commence until the first speed wheels are out of mesh, so that the period during which the clutch stop is enabled to effect its purpose is very small, and if the stop be inefficient, or if no stop be provided, it is often advantageous to make a distinct pause between the gears, *i.e.*, when the lever is in the neutral position.

In making *any* upward change which necessitates crossing the "gate" this pause is automatically brought about by the time occupied in the lateral movement of the gear lever, but where the change is by a direct backward or forward movement only, the habit of making a pause must be cultivated. It need be only very slight, and on some cars would amount to no more than a lingering over the operation.

The change from an indirect gear to the direct drive, where the latter is by dog clutches, is a procedure which requires special mention, for, although the conditions prevailing before and during the change are the same as in any other upward movement, the square shape of the dogs and their small number, and consequently the small number of available points of engagement as compared with a pair of pinion wheels, call for a firmer hold of the gear lever and slightly more "persuasion." A pair of dog clutches rotating at only very slightly divergent speeds—conditions under which a pair of chamfered pinions would almost engage of their own accord, or, at any rate, with no more pressure on the lever than could be exerted with one finger—will sometimes "kick-off" from one another unless the lever be held firmly; before the driver has again brought them together for engagement the relative speeds may have changed, the faster have become the slower, so that it will be necessary for the clutch to be let in again to speed up the clutchshaft before the dogs can be enmeshed.

In leaving the subject of changing up it may be remarked that, as a general rule, having very few exceptions, the greater the difference in the ratio of any two gears the slower should be the movement of the lever or the longer the pause between the two positions. This accounts for the fact that one often hears complaints of a car having a noisy change only from first to second, for the ratios of these gears are usually the most divergent.

Changing Down.

368 Many drivers who are able to change from a low gear to a higher without difficulty or noise hopelessly fail to make a change in the other direction—high to lower—with any amount of certainty that the operation will be successfully performed; successful, not only in the sense that the lower gear is engaged, but that it is done quietly and without shock to the transmission. More often than not, the bad changing is put down to some fault in the design of the car, but in all except a very small percentage of cases the fault lies with the driver.

As a preliminary it may be said that the conditions obtaining when a "change down" is about to be or is being made are exactly the reverse of those which occur in regard to "changing up."

Taking the change from third (direct) to second, and referring to the diagram (see hint No. 366), when the dog clutches forming the higher gear are engaged the clutchshaft is turning

at the same number of r.p.m. as the primary-shaft—comparatively slowly, say, 400 r.p.m. After the change into second speed has been made, the clutchshaft will be running at a much higher speed than the primary-shaft, provided the speed of the car be maintained, as it should be. Therefore, taking the speed of the primary-shaft as invariable, the necessity arises for an acceleration of the clutchshaft, and with it the layshaft, before the second speed pinions C and D can be enmeshed.

Imagine that a car is being driven on the third speed up an adverse gradient, and that, in consequence, the speed of the engine has decreased until a change to the second speed is essential; the following conditions prevail:

1. Engine is pulling hard with full throttle and running at, say, 400 r.p.m.; clutch, primary, and propeller-shafts turning at the same speed.
2. Layshaft with second speed driving pinion attached running at 200 r.p.m. owing to an assumed ratio of reduction of 2 to 1 by reason of the relative sizes of the constant mesh pinions.

Before it will be possible to engage the two second speed pinions, it is essential that the layshaft and the primary-shaft shall be running at the same speed, and the clutchshaft at double their speed. (To be more correct, one should say that the speeds of the two first should be in accordance with the ratio of the second speed pinions; these sometimes have the same number of teeth, so that it is approximately correct to say that the shafts shall be running at the same speed. This by the way.)

How is the layshaft to be accelerated? It can be done, and, alas! too often is done, to the accompaniment of much noise, by the driver depressing the clutch pedal and moving the gear lever so quickly and forcibly as to compel the layshaft to increase in speed by the grinding of the two pinions C and D against one another. If, too, the driver have depressed the clutch pedal to such an extent that the clutch has made contact with the clutch stop, the force with which the two pinions were brought together, and the ensuing noise, must have been greater, for, in touching the clutch stop, the clutch will have had a decided tendency to *decrease* in speed, whereas, as mentioned, a downward change of gear absolutely necessitates an increase of speed of the clutch and layshafts.

One method to be recommended, by means of which all noise and shock may be avoided, is as follows: With the throttle wide open, whether pedal or hand lever control, depress

the clutch very slightly, not much more than enough to make the clutch slip and the engine race; then move the gear lever without hesitation, but not hurriedly, from third to second.

Very simple, is it not? But it will be effective, with the very little practice that makes perfect, in ensuring a quiet change on the majority of cars.

This result is brought about by reason of the fact that when the strain of drive is removed from the engine by the clutch pedal being depressed, the engine will have jumped up in speed from 400 r.p.m. to perhaps 1,000 r.p.m. by reason of the throttle being wide open; simultaneously, however, the gear lever is moved, and therefore immediately the dog clutches of the direct drive are disengaged, the clutch, with its shaft and layshaft, will gather speed owing to the slight internal friction between the clutch and engine. (The writer holds the opinion that this internal friction is accentuated by what may be termed the air friction occurring between the two slightly separated clutch members.) The clutch stop has not been approached by the clutch during the process, so no retarding effect has been experienced from that source; the great desideratum having been obtained, *i.e.*, the clutchshaft accelerated, it only remains to engage the gear by continued movement of the lever.

All the foregoing explanation takes some appreciable time to read, but the period occupied by the change need only be momentary, for the acceleration of the clutchshaft occurs almost simultaneously with the disengagement of the third gear dogs if the clutch be not withdrawn too far.

An objection sometimes raised to this method is that the acceleration of the clutchshaft shows that power is being conveyed by it, which may do damage by the sudden "take up" when the pinions are engaged. To allay any fears on this score, it was demonstrated that the "air friction" and the friction arising from the internal clutch bearings was—although sufficient to accelerate the clutch rapidly—so slight that the movement of the lever could be made with one finger of the driver's hand, although this movement included the disengagement of the direct speed. It is obvious, therefore, that if the power conveyed had been at all appreciable, the flat driving faces of the dog clutches could not have been separated with so slight an effort.

Another Method of Changing Down.

369 Another method adopted by many drivers with success, in spite of its apparent complication, involves

a number of separate and distinct movements all leading to the positive acceleration of the clutchshaft and layshaft. The process is as follows :

1. Depress the clutch pedal, move the gear lever to a neutral position.

2. Raise clutch pedal so as to engage the clutch, but instantly depress the pedal again.

3. Move gear lever to next lower speed.

These movements having been made with the throttle half open, the effect of the second movement is to accelerate the clutch and layshafts, owing to the gears being in neutral; the third movement—the actual engagement of the lower gear—can, therefore, be made easily and noiselessly after very little practice.

One would imagine at first that this operation would occupy a comparatively long period; but, as a matter of fact, a gear can be changed in this manner with only the faintest perceptible hesitation.

A third method, hardly to be recommended unless great care be exercised and the knack attained very readily, is to change down, only *down*, without releasing the clutch.

This is best accomplished by (1) closing the throttle and taking out the higher gear simultaneously; then (2) opening the throttle and putting in the lower gear with only the faintest lead on the throttle manipulation.

The closing of the throttle in the first movement releases the drive from the teeth or dogs of the higher gear so that the gear lever can be moved without effort; the opening of the throttle just prior to the engagement of the lower gear accelerates the clutch and layshafts. Consequently, if the lever be manipulated with a very light touch—one finger is sufficient—the gears will drop into mesh when the pinions assume the same rate of revolution.

There are several variations of the three foregoing methods, but they may be taken as typical. In the opinion of the writer, the first mentioned is the most preferable, perhaps because he has used it successfully for many years on a large number of different makes of cars.

Changing Down in Traffic.

370 The advice previously given has had particular reference to changing from a high gear to a lower when hill-climbing, but it is evident that, under certain conditions, such as when driving in traffic, the methods described cannot always be followed.

A very frequent situation is as follows: On top speed a car has been driven slowly through a town, but, owing to traffic conditions, has been slowed down behind a vehicle moving at a lesser speed. This has necessitated releasing the clutch, with the consequence that a lower gear must be engaged before the car can "get away" again. Under such circumstances many drivers make more noise and experience more difficulty in changing than under normal conditions when ascending hills. The reason of this is that there is even more inclination in traffic than when on hills to depress the clutch fully when changing down, and it has been previously mentioned that this results in the clutch touching the clutch stop, so decelerating instead of accelerating the clutch and layshafts.

Therefore, under the circumstances described the plan to adopt, when the moment arrives for a change down to be made, is: With the throttle open about one-sixth of its travel (or enough to make the engine run at a speed which would be described as "rather too fast" if the car were stationary), partially release the clutch pedal so that the clutch is almost engaged, and then move the gear lever slowly from one gear to another with only the amount of force that could be exerted by one finger.

The reason for causing the engine to run "rather too fast" is to ensure that it shall be running faster than it would be if the top gear were driving, so that the internal friction may, while the gears are crossing the neutral zone when the change is being made, accelerate the clutchshaft to the speed at which it will be running when the lower gear is in mesh.

To conclude on the subject of changing down, the driver should always remember that the clutchshaft *must* be accelerated before the pinions are meshed—if this desideratum be not effected by one of the methods suggested (all of which use the engine as a medium) it can only be accomplished by forcing the two pinions together and compelling the ensuing friction and grinding to speed up the slower one. A brutal method, surely; far better take pains and adopt a well-thought-out plan, practising it over until perfect gear changing is assured.

Engaging the Reverse.

371 The enmeshing of the reverse gear is an operation over which the writer has at one time and another seen (and heard!) a great deal of fuss and bother; and the difficulty experienced by some drivers is doubtless due to the

fact that with many gear boxes the operation involves the enmeshing of one pinion with two others, either simultaneously or consecutively. If all three pinions be at rest, as two of them will most certainly be if the car be stationary, it is not difficult to appreciate that the engaging of them will not be an easy matter, for it is many chances to one that either one pair or the other will be in an incorrect position for enmeshment; that is to say, each tooth will not be opposite its space. Now, if the clutch be fully depressed and the clutch stop be strongly brought into use, the chamfering of the teeth will not allow those which are incorrectly placed to draw into one another. If the clutch be only slightly depressed, just enough merely to touch the stop, the various shafts will be free to rotate through the few degrees necessary to allow the chamfered teeth to register. When the gears will not engage immediately, it is useless to jerk the lever to and fro in the hope that force will attain the end in view; instead of jerking the lever a light pressure should be maintained upon it and the clutch pedal raised gradually meanwhile, so that at the moment the internal friction of the clutch tends to rotate the shafts the pinions may be quietly engaged as the respective teeth and spaces become opposite to each other.

A great fault with many drivers is to attempt to engage the reverse after using a forward speed before the car has come to rest or *vice versa*. This means that they attempt to engage pinions which are running in opposite directions! An utter impossibility, of course, to attempt which means noise, grinding, and wear.

Gear Changing in a Nutshell.

372 Briefly to summarise all that has been recommended on the subject of gear changing:

FROM NEUTRAL INTO ANY GEAR.

Depress clutch fully and move lever gently into the gear notch after a brief period of hesitation.

CHANGING UP (from a low gear to a higher).

Depress clutch fully, and move gear lever slowly but firmly from one position to the next.

CHANGING DOWN (uphill).

Depress clutch pedal very slightly with throttle wide open, and move lever quickly from one gear to another.

CHANGING DOWN (after a traffic check).

Open throttle slightly, and with clutch almost engaged move gear lever gently to next position.

REVERSING (when difficulty is experienced in the engagement of the pinions).

Depress clutch, put a light pressure on the gear lever, and whilst maintaining that pressure slowly raise the clutch pedal until the gears engage.

In conclusion, it must be impressed upon those who have not considered the matter that all noise and shock in connection with gear changing mean unnecessary wear—unnecessary because it *can* be prevented by drivers who will take the trouble to use judgment and care in the various operations, instead of merely manipulating the gear lever and clutch pedal in a happy-go-lucky way. Wear is occasioned not only to the teeth of the actual gear wheels which are being operated but to the transmission gear generally, for a noisy change is usually followed by a jerk when the clutch is let in, with the consequence that the propeller-shaft, worm, or bevel drive, axles, etc., are all submitted to stresses above the normal. But, apart from this, the unnecessary wear inside the gear box is a sufficiently serious matter to call for the adoption and use of some method which will obviate its occurrence.—M.

CLOTHES AND HEALTH.

Winter Driving: How to Keep Warm in an Open Car. —How to Keep Warm: A Few More Hints.—The Ailments of Motorists and How to Avoid Them.—Motoring Headaches.—Care of the Motorist's Hands.—To Clean the Hands.—Another Method.

Winter Driving: How to Keep Warm in an Open Car.

373 For the seasoned and experienced motorist who drives his car through summer and winter these remarks are not intended. They may be useful, however, to those who are purchasing a car for the first time, or to the summer motorist who, as a rule, lays up his car for the winter. The joys of winter motoring are many, so long as one can *keep warm*, and, needless to say, it is not given to everyone to be able to stand the rigours of our erratic climate in an open car in winter. It stands to reason, of course, that the one who pays most attention to the general health, digestion, and care of the body will get most out of his car in winter, and it is important to note that one should never start out feeling cold. A few simple movements of the limbs—a smart fifty yards run, for instance—will improve matters by starting circulation. The car starts, and, no matter how comfortable driver and occupants have felt at the beginning, the cold air will soon begin to find out the weak spots.

I venture to say that not one in twelve motorists breathe properly either on or off a car, and correct breathing is one of the most potent factors in keeping warm. Just notice the number of people one meets who breathe through the mouth. No wonder cold is felt; the air lacks the warming it ought to get through the nasal passages, to say nothing of the purifying effect of passing through the nostrils. Breathing should be slow, deep, and regular—through the nostrils, not through the mouth. Try this when the cold air begins to make itself felt. Take a long, deep breath as slowly as possible, hold it for a little, then expel the air as slowly as you can, and repeat. It is surprising how this simple exercise will counteract the effect of the cold air, besides being excellent for the lungs. Putting it shortly, keep the mouth shut, for breathing purposes at any rate.

Then as to clothing. This is too individual a matter on which to lay down any hard and fast rules, but it is to be noted that the clothing worn next the skin is the great factor in keeping the body temperature right. This is assisted, of course, by the use of leather and fur-lined coats, rugs, comforters, and the like. The critical places in the armour of the winter motorist are the neck, wrist, and ankles, the blood vessels in those parts being just under the skin and most liable to chill. The writer uses a medium-weight sweater very high in the neck and long in the sleeves, worn over the waistcoat. The sleeves come right down over the gloves like mittens, thus dispensing with the use of tight wind cuffs, such as are customary on motor coats. Those wind cuffs as a rule do far more harm than good by being made too tight and impeding the circulation.

Attention must be paid to the gloves. They must not be too tight, and woollens are preferable for winter use. The best glove which has come under the writer's notice is all wool, with leather on the palms. It has three compartments only—one for thumb, one for first and second fingers, and the last for third and fourth fingers. With regard to the feet, I think it will be admitted that one can drive better when using thin soled, comfortable boots—with thick soled boots the clutch cannot be felt as it should be—and on a long run in winter there is nothing better to keep the feet comfortable than the use of a pair of cheap and heavy workmen's woollen socks put on right over the boots and drawn up over the ankles. They are easily removed, and well worth the trouble of pulling off before dismounting from the car.

It is well known that spirituous liquors actually lower the bodily temperature, and should be avoided on this account while driving. On the other hand, hot tea and coffee are very useful.

In driving without a screen in winter it is well to remember that just in front of the ear is the seat of the large ganglion which supplies the nerves to the face, and, rather than run any risks, it is advisable to wear a Jaeger helmet of wool which will completely envelop ears, cheeks—in fact, the whole face with the exception of nose and eyes.

The virtues of the hot mustard bath after a day's exposure are not sufficiently well known. The essential oil found in mustard is not only a good prophylactic against chill, but is also a good sedative to the nervous system, counteracting the wearying effects of vibration whilst motoring.

A few cases of rather severe eye inflammation have come under my notice. This is remedied by using plain glasses and bathing the eyes after a run with a little baking soda in hot water.

In conclusion, it is the small things that tell in getting the most comfort out of the car at this season, and it is interesting to note that manufacturers are now paying more attention to the comfort of the car user by fitting torpedo bodies, high doors to front as well as back seats, and the like. It behoves the car owner who knows how to dress and keep warm to impart the information to his invited passengers before taking them out for a run.—PAGE.

How to Keep Warm: A Few More Hints.

374 1. Use half-goloshes — rubber "over-shoes" — covering the toes only, so that the feet can perspire freely between the boot-laces.

2. One man, one rug. A big rug admits draughts which are excluded by small rugs wrapped around each passenger.

3. Do not cultivate the habit of wearing scarves or mufflers, but drive with the neck free to the air, reserving these protectors for exceptionally cold times.

4. Wear two pairs of "Canadian bags"—like babies' gloves—with a thumb but no divisions between the fingers; thus the fingers are free to move about, and the friction against each other promotes warmth. Two thin pairs are better than one thick. Even the best sealskin gloves are usually lined with cheap fur, the skin upon which is watertight and prevents perspiration exuding; thus they become damp inside, and the hands are cold in an hour.

5. The cold tub in winter should not be of a temperature lower than in summer. Take the chill off.

6. After motoring—or, indeed, under any other circumstances—when changing to evening dress, either have a cold tub, or, at any rate, stand in a few inches of cold water and splash the feet about for half a minute; then rub them very dry with a rough towel before donning evening socks.—A. J. WILSON.

The Ailments of Motorists and How to Avoid Them.

375 Motorists' ailments are, fortunately, for the most part of so slight a degree that they may almost be classed as "discomforts"; still, cases repeatedly present themselves in which the stage of discomfort has been passed and a true ailment exists. Most of us, after one or two years'

driving, will quite appreciate the fact that there is nothing so efficient as motoring (in this erratic climate) to find out unexpected weak spots in our anatomy, and the object of these notes is not so much to suggest the cures as to deal with the prevention of ailments which might be caused by motoring.

Taking first of all the ailments due to exposure, it has been pointed out in hint No. 373, that the important factors to consider in avoiding trouble (in winter driving especially) are attention to breathing and clothing. Breathing should be full, deep, and regular, and through the nostrils; any obstruction of the nasal passage ought to be attended to at once, for there is nothing more productive of chill, and its sequelæ, than mouth breathing. As regards clothing, it must be remembered that it is the garments *next* the body which count—these should be easy fitting, not tight; the external garments are, after all, mere accessories in keeping the body at a normal temperature.

The fallacy of the wind cuff has been commented on ere now; the idea of preventing cold air reaching the arm, at the expense of interfering with the blood circulation of the hand and wrist, is distinctly bad practice.

Clothing.

It is difficult, of course, to put down any hard and fast rule with regard to clothing suitable for the car, as individual constitutions vary so much in their susceptibility to cold; but the younger drivers must remember that the argument of bodily fitness and ability to withstand the rigours of our climate (acquired, for instance, on the football field, in scanty clothing) does *not* hold good in motoring; besides which, it is no sign of molly-coddling to use every endeavour to avoid chill whilst on the car. The cult of the torpedo body has done much to promote the comfort of the motorist. The only objection one has to offer to this type of body is that on a warm day the occupants of the front seats are subjected to a sort of Turkish bath in so far as the lower limbs are concerned, with consequent discomfort. This condition of affairs may easily be remedied by having the near side front door detachable, so that it can be unshipped in hot weather, and thus permit a current of air to pass along the floorboards.

It will be noted from the foregoing that much stress is laid on the subject of keeping the body temperature normal, for when chill is felt it must be taken as Nature's warning that all is not well, and the sub-normal condition should be corrected accordingly. This result may be achieved in various

ways, *e.g.*, by exercise or movement, by the drinking of hot tea or coffee, or by taking a light meal. While mentioning food it may be stated that in touring the correct time for a good substantial meal is after the drive is over, not in the middle of the day. Food taken during the drive should be light and sustaining, and may with advantage be carried on the car. At the end of the day's drive a hot mustard bath (winter and summer) should be taken, to be followed by a good meal.

The mustard bath is in every respect a perfect cure for the "on edge" sensation experienced by many, being an antidote to the effects of cold and a sedative after the strain of continued vibration. Of the various neuralgiæ which may affect the face and head, little need be said here; their presence will indicate a visit to either doctor or dentist. Some of the fair sex might, however, remember that the large "wind-catcher" type of hat is quite out of place in an open car whilst touring, and that this, with its multitudinous hatpins and tight motor veil, is a frequent cause of headache.

Taking the ailments of joints next, the ankle, knees, and wrists have much work to do in the driving of the car, and it is to the driving that most of the troubles are due. The wrists may suffer from the wind cuffs being too tight (as they usually are), from undue vibration, or overwork due to faulty steering (the remedy in the latter case is obvious). The bucket type of seat offers the most complete comfort to the wrist, as it affords a means of resting the elbows, and thus relieves some of the strain on the wrist.

With regard to the knee and ankle joints it is surprising how motorists have so long permitted themselves to accept whatever disposition of dash, clutch, brake, and accelerator the manufacturer chooses to offer.

Driving Position.

In many cars it will be found that the driving position is one of extreme discomfort in so far as the lower limbs are concerned, the maker's idea evidently being that one stereotyped arrangement will suit all drivers. Let a man sit on a chair with the upper and lower parts of the legs at right angles, and see how long he can sit in comfort in this position; yet this is exactly what is often found in the driving seat of a car. Add to this also the manipulation of the pedals, vibration, exposure, and it is evident that the joints of the leg do not get a chance of doing their work properly. The position of greatest ease for the lower limbs is that of semi-extension,

and it follows that the dash should be so placed that it can only be touched with the toes; the clutch, brake, and accelerator pedals should be in such a position that they can be manipulated with the sole of the foot, the heel resting on the floorboard.

Presuming that the driver has been measured for his seat (the correct procedure), and that after or during driving he finds pain and discomfort in the right knee or ankle, he may possibly be able to diagnose the cause of the trouble. If the car be fitted with both accelerator and throttle control on the wheel, and if the driver use the accelerator constantly, he may find the limb much relieved by driving on each control alternately. Similarly with the left leg, many joint troubles have been ameliorated, if not entirely cured, by giving a little attention to the condition of clutch leather, springs, and brake.

Should pain, swelling, and discomfort persist in a joint, hot salt water fomentations may be tried, or a stimulating liniment applied; should these fail to cure, medical advice must be sought at once, as these symptoms may be only the local manifestation of some serious general condition. The joints of the lower limb are complex pieces of mechanism, and no time should be lost in getting troubles in connection with them attended to, for fear of chronic mischief.

The Neglect of Proper Exercise.

Motoring has been blamed for having produced a class of men who, in their zeal, are neglecting the exercise which is necessary for the maintenance of a healthy body, and thus increasing the severity of ailments which are induced by a sedentary life. Possibly so: the same may be said for the excessive use of cabs, railway trains, and tramcars. There is one very important fact that must not be lost sight of, and that is, motoring has produced a class of able, intelligent, and observant men who, in many cases, previous to owning a car had not even the most elementary knowledge of mechanics, but after a little experience are able not only to drive, but look after their cars themselves. In this they find ample scope for exercise to counteract any ill effects which may accrue.

The writer, when he hears motoring described as a lazy pastime, has always a longing to give the critic the job of taking off an 880 × 120 mm. cover, and replacing a steel-studded tyre on a wheel of the same size. This would most likely prove an eye-opener to the critic with regard to the exercise that may be obtained in attending to one's own car. Fortunately, the changing of tyres is not a constant job, but

the owner who takes an intelligent interest in his car need never lack exercise. This interest, by the way, also serves as a remedy for the very distressing complaint which evidently afflicts some car owners, the ailment of indifference. How some, otherwise acute, individuals can "leave all to the driver" simply passes comprehension; that this complaint is rather common is proved by the number of letters on "Corrupt Practices" and "Chauffeur's Duties" which reach the correspondence columns of *The Autocar*, the gist of most of which seems to be that the chauffeur has evidently changed places with the owner.

DANGER OF BECOMING TOO NEARLY AUTOMATIC IN DRIVING.

Finally, there is a condition which affects many drivers after the novice stage is passed, and to which the term ailment can scarcely be applied—the driving may become automatic.

This automatic action is made manifest in many incidents of everyday life, and is engendered by what is known as force of habit. Take, for instance, the action of walking up a flight of familiar stairs in the dark, the while the mental faculties are engaged in consideration of something totally different from climbing stairs. Or, again, while driving along a well-known road, one comes to a hill which necessitates a gear change; the change is made by force of habit, or, in other words, automatically.

The condition has nothing akin with sleep or carelessness, and is not to be confounded with the torpor of the average driver of the horsed vehicle, who at least has an animal in front of him possessed of what is termed "horse-sense," though the driver may be lacking in that faculty.

Motor driving seems to lend itself particularly to this condition. There is, first of all, the (as a rule) monotonous regularity of the mechanism of the car, the knowledge of safety of the vehicle on the road, and the practice which has developed driving into a habit. How acute the faculties were during the first few attempts at driving! There was no danger of automatic driving to begin with. Corners were taken slowly in anticipation of someone coming round on the wrong side, every nerve strained, and the faculties acute. In short, there was a full degree of consciousness. Then, as confidence was gained, and practice made the driving more perfect, there was the gradual transition from perfect consciousness, and very little mental effort was necessary, the driving being ultimately performed all but unconsciously.

In the earlier days automatic driving was not common, for as a rule the driver had too much to attend to. Many will

remember the examples of queries from readers which appeared in the motor journals, "Is it right to zigzag uphill?" Now, however, with under-geared three-speeded cars of the "everything-on-top" style, it is quite easy to see how the driver, having so little to do, is liable to let the mind wander, and it would be interesting to know how many accidents said to be caused by failure of steering gear are really due to automatic driving.—A MEMBER OF THE MEDICAL PROFESSION.

Motoring Headaches.

376 Some drivers suffer from headache after long runs, especially at speed or in cold weather. The cause of this is usually too thin a cap, permitting the head draughts to beat on the temples and upper front of the skull. Some drivers avoid them by reversing the cap and wearing it peak astern, which does not conduce to a decent appearance. Motoring tailors have not yet learnt to make the front of a cap thick enough, but it is an easy matter to line the front of any cap above the peak with chamois leather, which will generally cure any tendency to headaches. It is also well to bear in mind that a tight cap will have the same effect in bringing on a headache.

Care of the Motorist's Hands.

377 How do you keep your hands clean? This is a very hard question to answer if you are a motor enthusiast. There are several conditions, however, which, if understood, save much trouble in cleansing the hands after motor work. From experience it will have been noticed that the sole reason for motor dirt being hard to remove is the irregularity of surface to which it is applied. Cracks round and under the nails are the most difficult places to clean, next the creases on the fingers and thumbs. Given a smooth hand, very little dirt will stick. Therefore, do all that is possible to keep the hands smooth. This is a cardinal point. To do this there are several points to observe—

1. Remove the dirt without roughening the surface.
2. Fill the interstices of the skin before starting work.
3. Avoid chafes, chaps, and rubs, *i.e.*, knocking the skin off the knuckles and exposure to wet and cold.

1. The answer to this question is: Avoid all coarse forms of soap; never scrape the nails with a knife; never use

Sapolio, Monkey soap, or an alkaline substance whatever. Do not use petrol to wash hands in ; it coarsens the hands very quickly.

2. Gloves are uncomfortable to work in, so before beginning to work, rub the hands all over with clean oil, wipe the surplus off, and with a fine toilet soap fill the nails and cracks round, and avoid contact with water till the job is over.

3. If necessary, wear gloves with the finger ends cut out.

A supply of linen rag and antiseptic ointment ought to form part of the accessories both of the car and motor house for the prompt treatment of cuts ; in the case of bruises and sprains, a hot water fomentation (as hot as can be borne from the radiator if necessary) and the part bound up firmly is the proper treatment.

To Clean the Hands.

378 Use warm *soft water*, good toilet soap, and a nail-brush for the nails. When it is important to have the hands perfectly free from black, as may be the case with a doctor, do not be too violent in the efforts to cleanse the hands thoroughly. It is wonderful how a few hours seem to loosen the dirt. The use of oatmeal has also been recommended as very efficient for cleansing the hands from grease. Some cleansing preparations put up for the use of motorists have the unfortunate knack of removing not only grime but the superficial layer of epidermis as well, and ought to be shunned on that account.

Another Method.

379 In reference to this subject a medical motorist writes : "Let me direct your attention to a simple procedure which I have found very efficacious in rapidly removing motor dirt. The procedure consists in (1) wiping off as much dirt as possible with newspaper, (2) anointing the hands freely with Lanoline, and (3) washing in hot water with toilet soap and nailbrush. If the Lanoline be well rubbed over the hands, it will be found that all traces of dirt will be removed from cracks and creases with very few minutes' washing, the hands being left both white and soft. Since I hit upon this method I have discarded the use of gloves, and the method has the further advantage of requiring no preparation of the hands before beginning work. Lanoline can be carried in collapsable tubes as part of one's kit. I can strongly recommend this use of the substance to brother medical motorists, to whom its properties are familiar in other spheres."

MAKESHIFTS ON TOUR.

By Way of Introduction.—Broken Exhaust Valves.—A Suggested Addition to Spares Carried.—A Steering Gear Repair.—Repairing a Starting Handle.

By Way of Introduction.

380 During the course of some years' experience with cars of numerous types and various powers I have necessarily had occasional troubles which required a certain amount of ingenuity to overcome, in the absence of spares or a well-stocked garage. I have never yet experienced a difficulty which has caused me to leave the car where the trouble occurred—good luck, no doubt. At the same time, some of the mishaps both to car and engine that I have experienced, and the way in which such were temporarily put right, may be of interest, and perhaps of help, to those who may find themselves in a similar position.

Broken Exhaust Valves.

381 For instance, some time ago I had a car, the engine of which (a four-cylinder) gave a deal of trouble on account of the exhaust valves breaking. The exhaust valve spring was of that type which, instead of being fitted with a cap and cotter, was bent hook shape at the bottom end, the hook being slipped through a slot in the stem of the valve. The point of breakage was always at the slot in the valve stem (see fig. 1). On two occasions I had a spare valve with me, but on the one to which I wish to refer the spares had by some mischance been taken out of the car and not replaced. Well, the valve snapped, with its usual absence of warning, about three miles from a small town, whilst we were on tour to the North, and then—and not until then—I found that the spares had been left at home. I therefore ran into the town mentioned on three cylinders, and whilst having lunch attempted to think of some way out of the difficulty without waiting for the spares to be sent on, for I guessed that it would be impossible to obtain a new valve in the town. At last I hit upon, and carried out with the help of a local cycle repairer, the following repair: We first smoothed with a file the end of the valve stem B (fig. 2) where it had broken, and then cut a piece of steel G of the same diameter to a length which gave it a slight clearance between the valve in position

and the tappet H at its lowest point. We next found a piece of steel tube F which was an easy fit over the tappet, valve stem, and steel piece. This tube we cut to such a length that it enclosed the two former at its extreme ends, holding the steel piece G in position between the two. The only thing now to be done was to find a method of adapting the spring A to the shortened stem of the valve, and we managed this by cutting a screw thread E on the latter, shortening the spring by cutting off the hooked end, and fitting under the spring, when in position, a large washer C, a nut, and a thin

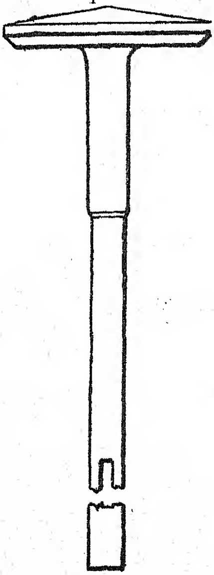


Fig. 1.—Broken Exhaust Stem.

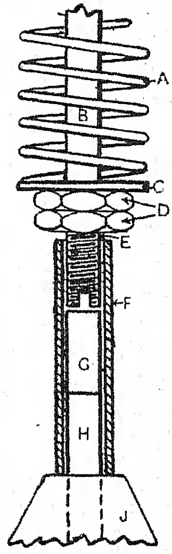


Fig. 2.—Stem Repaired.

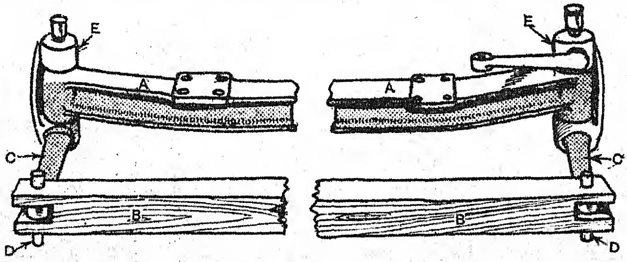
locknut D. The whole, when complete, was somewhat as shown in fig. 2. We found it worked perfectly, and that it was of no consequence whether the piece of tube lifted with the valve or not. If it lifted, the bottom end did not clear the tappet; if, on the other hand, it did not lift, the end of the valve stem did not rise above its top end. The time occupied on the makeshift was less than an hour, and although I had the spares sent on to me from home, the arrangement was so satisfactory that I found it unnecessary to fit a new valve until after my return.

A Suggested Addition to Spares Carried.

382 With reference to the above, I think it would be a very good plan if, with their usual spares and tools, all motorists carried three or four lengths, of various diameter, of silver steel. I have found it extremely useful, and, in fact, on several occasions the absence of it would have caused hours' delay, to say the least, and probably have necessitated my having to leave the car, go home or to the nearest town, and send someone to put things right. Many of my friends say, "A piece of wire, a pair of pliers, and a file will always bring you home," but give me a piece of steel in addition to these articles, and I think I may say that "I'll get there—and back."

A Steering Gear Repair.

383 Another roadside repair which enabled me to reach home (a matter of thirty miles) without great delay was on an occasion when—and let me say at once that *I*



A, ends of front axle.
B, piece of wood used as a temporary distance rod.
C, steering arms.
D, temporary pins.
E, steering centre pins.

was not driving at the time—after running into the back of a waggon we found that the damage consisted of a broken coupling rod in the steering gear; in other words, the rod which connects the two front wheels. The steering arm on the near side was also slightly bent, but the rod had broken off short about 1½in. from the bolt hole. We fixed up a temporary repair, not troubling to straighten the arm, in the following manner: We removed the rod entirely, and from a cottage near by obtained a piece of wood B B (called quartering, I believe), the section of which was about 3in. square. This we cut off to a length of 3in. in excess of the distance between the bolt holes on the steering arms with the wheels parallel, making a slot of about 2¼in. in each end of the arms C C

to fit into. Now came the difficulty of making holes through the ends to fit bolts through. A drill and brace were not available, and eventually we hit upon the plan of burning two holes with a red-hot poker, which we obtained and heated at the cottage. The bolts we had taken out were, of course, too short to go through 3in. of wood, and as we had none on the car of sufficient length, we were compelled to use the best material we had for the purpose. This proved to be the large "tommy" for use with the box spanners. We filed it partly through at the centre, broke it in half at that point, and fitted the two pieces D D, one at each end, through the holes in the wood and steering arms, wiring the extemporised bolts in position. We reached home safely, but, as can be imagined, no "speed bursts" were indulged in, the rate in miles per hour being such as to satisfy the most critical man in blue. Moreover, we inspected the repair (!) every few miles, and noticed with increasing anxiety that the joints were developing considerable slackness before our destination was reached.

Repairing a Starting Handle.

384 I was once, in company with a friend, descending a hill, when a noise was heard which sounded as though some part had become detached, and in falling had

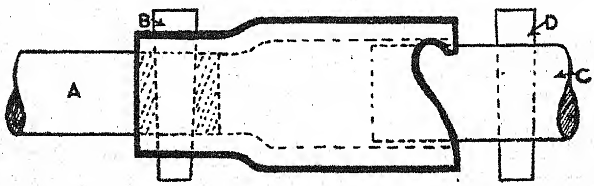


FIG. 1.—REPAIRING A BROKEN STARTING HANDLE-SHAFT.

A, end of starting handle-shaft. C, end of engine crankshaft.
B, taper pin securing steel claw to handle. D, taper starting pin.

struck or rebounded against the crank chamber or gear box. On looking round we saw something in the road, which, on closer inspection, proved to be the starting handle, or rather a portion of it. The handle was of that type which has a hollow piece of turned steel fitted to the end near the engine, shaped out to "claw" a pin on the front end of the crank-shaft, this hollow piece of steel being secured to the handle by means of a thick taper pin (fig. 1). What had happened was this: The taper pin had fallen out and the handle had gradually worked forward, thus allowing the hollow piece to

drop. Then, or perhaps some little time after, the handle had fallen out of its bearing. We could not find the "claw" piece, although we walked back about two or three hundred yards, and without this we could not restart the engine, for unfortunately I had stopped it when pulling up; if I had not done so it would have been an easy matter to have driven to the nearest blacksmith's shop and have obtained a piece of steel to take the place of that we had lost. But having, as I say, stopped the engine, we had to devise some means of making a temporary starting handle. We first tried the plan of pushing the car when in gear and then letting in the clutch sharply, but there being only myself and a friend we could not get sufficient "way" on the car to obtain the desired result. The following idea was suggested: I had a set of tube spanners on the car, and that for the smaller nuts was drawn out at one end to a smaller diameter than the body of the spanner. We filed off a length of about 2in. at this end, and were then possessed of a piece of steel nearly the same shape as that we had lost, but, of course, much thinner. Having no means of drilling a hole at the drawn end for a pin to pass through, we made two slots, as shown in fig. 2, with a round file. The necessary claws in the large end were also filed to a shape deep enough to answer the purpose temporarily. When fitting the makeshift together I used a bolt and nut instead of a taper pin, and by so doing the whole thing was practically as firm and without likelihood of becoming detached as if a hole had been drilled and a pin used. The filing of the slots at the one end and the "claws" at the other was, naturally, an awkward piece of work, and occupied some time, for the only means I had at my disposal for holding the tube during the process was a small hand vice. This "fake" was sufficiently successful to cause us to come to the decision that there was no necessity to obtain anything else in this direction before we arrived home, for the engine was started some fifteen or twenty times by the means we had provided. The makeshift cost me the price of a new tube spanner, but my experience is that to enable home to be reached without great delay there are many fittings of greater value than a tube spanner that one would cheerfully surrender for the purpose.—MARCUS W. BOURDON.

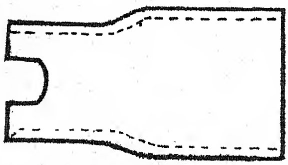


FIG. 2.
ANOTHER STARTING HANDLE REPAIR.

RECHARGING ACCUMULATORS.

The Various Methods Employed.—Cost of Different Methods.—The Most Economical Method.—A Steadying Resistance.—Charging through Lamps as a Resistance.—Pole Finding and Connections.—Lighting and Charging.—Charging Accumulators from an Electric Light Plant.—Charging from an Alternating Circuit.—When to Charge up Accumulators.—Charging Accumulators on High Voltage Circuit.

The Various Methods Employed.

385 There are several methods of charging accumulators. Of these the commonest are:

(1) Charging from electric mains, using lamps solely as a resistance.

(2) Charging from electric mains, using as a resistance lamps which would in any case be required for lighting purposes.

(3) Charging from primary batteries.

Of these the first is the commonest, and often the most extravagant. The second is by far the best when feasible. The third might well be more extensively used in cars where an electrical supply is not handy.

Many car owners prefer to send their accumulators away to be charged, rather than adopt any of these methods.

For those living in towns the matter is, as a rule, fairly simple. It is only necessary to find an agent with a suitable charging apparatus and some knowledge of electricity, who can be trusted to do his work properly.

Unfortunately, many agents are absolutely ignorant of the subject, and do more harm than good. Small central stations are also often unsatisfactory. Many central station engineers have little or nothing to do with accumulators, and the profits accruing from the charging are so small that but little care is taken. We have seen and tested accumulators, in a perfectly satisfactory condition, just returned after being charged at a central station, and in some cases have found them to run down to about a quarter of their full capacity.

Again, some who live in the country send their accumulators by train to the makers or others to be recharged. By this means they can be sure that the recharging is done

properly; but railway travelling is by no means good for an accumulator, and its condition when it arrives home is very doubtful.

Lastly, it is particularly easy for unscrupulous people to take advantage of the fact that an accumulator, when only about half charged, will, after a rest, show a very fairly high voltage.

In short, if you have no good reliable agent near you, you must do the work yourself.

Cost of Different Methods.

386 Now, as to the method to be employed, we may consider: (1) First cost and (2) cost of charging. In respect of the first cost, charging through a lamp, or lamps, as resistance, has the advantage. A suitable charging board can be made, or even bought, for a few shillings.

The cost of charging varies with the voltage of the mains. To take an average case, suppose the supply to be at 100 volts. To charge a 30-ampère-hour accumulator we require, say, two ampères for fifteen hours. To get this we must use two ampères at 100 volts (= 200 watts) for fifteen hours; that is, we use $\frac{200 \times 15}{1{,}000} = 3$ kilowatt hours. Taking the cost of a kilowatt hour at an average of 5d., the cost of charging works out at 1s. 3d. Now, of the power used, only about 5% goes to charging the accumulator, the remaining 95% being wasted in lighting the lamp. If we charge, say, three accumulators at one time, the cost is the same, or, in this case, 5d. each. Indeed, twenty accumulators might be charged at one time in series for the same cost—that is, at $\frac{3}{4}$d. each.

This method is, then, only economical when the number of accumulators dealt with is considerable.

On a 50 volt circuit the cost of charging one cell at a time would be $7\frac{1}{2}$d., while on a 220 volt circuit it would be over 2s. 6d.

The Most Economical Method.

387 The second method—that of charging through lamps, which would in any case be used for lighting purposes—entails a certain amount of first cost, which varies under different conditions, some slight alteration in the wiring of a room being required.

Car owners who have electric light in their coach-houses could, without much difficulty, get the necessary wiring done by an electrician at a small cost.

The accumulators would then be charged when the lights happened to be required. The only effect would be slightly to decrease the light given by the lamps. Neglecting this, the charging would cost nothing. Another good result of working on these lines would be that the accumulators need never be run down, but could conveniently be kept always nearly fully charged.

This method of charging (little and often) is also to be recommended if primary batteries are employed; always supposing, of course, that proper care is taken to put in to the accumulator as much current as, or rather more than, has been taken out in driving.

The first cost of primary batteries is not so great as might be supposed. A good four-cell battery, which will work well on the lines suggested, can be constructed without any very skilled work for a small sum, and a suitable regulating resistance for a mere trifle. With this battery the cost of charging should work out at about 9d. for a 30-ampère-hour accumulator, but varies under different circumstances, and could doubtless be brought considerably lower if all materials were entirely used up before they were replaced.

A Steadying Resistance.

388 With all forms of primary battery it is advisable to use a steadying resistance of some sort. Even a battery which has by no means a low internal resistance will be found to send a current of four or five ampères through an accumulator when first connected up. With many other batteries a resistance is still more necessary, and there are many forms to be had, most of which will answer the purpose. A slight disadvantage of some of these is that they do not allow of a steady gradual change of resistance being effected. A good form is the carbon resistance, but it is our intention here to describe a type which can be more readily constructed without skilled workmanship.

A planed deal board about 15in. long and 4in. wide will serve as a base. About 1in. from each end strips of some insulating material are placed across the board. As it will be necessary that these strips should take several screws without cracking, ordinary deal would not be suitable here.

A good material for the purpose is the three-ply wood, which can be obtained from any dealer in fretwood. The strip A (fig. 1) measures about $3\frac{1}{2}$in. $\times \frac{3}{4}$in. $\times \frac{1}{4}$in. thick. At B two strips are used, so that the total thickness is $\frac{1}{2}$in.

For the resistance itself, about 10ft. of platinoid wire will do well. In ordering this, it should be specified to take from six to eight ampères. In this case it will not heat unduly at the ordinary charging rates. One end of this wire is fastened to the wing terminal T—. The first screw at A is then partly screwed in, and the wire is twisted tightly round the shank, and then passed along the length of the board, round the screw on B, and back to the next screw on A. At this end it passes round two screws nearly touching one another before returning to B. The wire is given a complete turn round the shank of each screw before going on to the next. When about ten lengths of wire are completed, the screws may be screwed home, which forces the wire out round the heads, and so tightens it up.

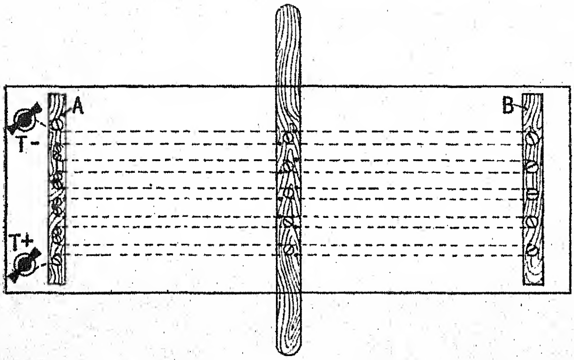


FIG. 1. PLAN OF ADJUSTABLE RESISTANCE BOARD.
A B, insulating strips three-ply wood. T— T +, terminals.

It may be further tightened by a strip of wood placed edgewise like the bridge of a banjo, and forced up near to A, raising the wire to an equal height at each end. The loose end of the wire is attached to the terminal T + .

Between T— and T + is a strip of brass or copper, or a piece of heavy copper wire. In the first case, its shape would be that shown in fig. 2. The end E is attached to terminal T +, and the slot at the other end is secured to T— when it is desired to "shunt" the resistance out of circuit.

The adjustment of the resistance is effected by the strip S S of three-ply wood (fig. 3) sliding beneath the wires.

The method of obtaining contact is shown in fig. 1, and is enlarged in fig. 3. In the latter figure the bend of the wire

caused by the screws is somewhat exaggerated. The two small screws G S, G S press the wires firmly against the shank of the larger screw, giving a good contact, and the more the resistance is used the better the contact becomes, since the surfaces are worn flat by rubbing. The advantages of this method are: (1) The wires are kept straight, since the motion of the sliding piece is such that all bends or kinks are gradually straightened. (2) The surfaces giving contact are kept bright and clean by the rubbing of the screws.

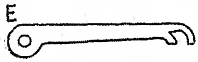


FIG. 2.—SWINGING BRIDGE PIECE TO OPEN OR CLOSE THE RESISTANCE.

It will easily be seen that when the sliding strip is in the position shown, all the wire at the side B of the strip is shunted by the screws in the strip. Consequently, the nearer the sliding strip is to B, the greater is the resistance offered to the current.

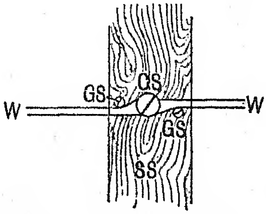


FIG. 3.—DETAILS OF STOP IN THE SLIDING BRIDGE.
W W, wires. G S, guide screws.
C S, contact screw. S S, sliding strip.

This resistance may be screwed on to the front of the box containing the primary battery, the only alterations necessary in the wiring being that the wire from the first carbon passes to T—, the current flows through the resistance, or through the copper shunting strip, and the + terminal of the accumulator is connected to T +.

The use of the resistance is very simple. When first connecting up, put the whole resistance in circuit, and gradually diminish it, and finally cut it out altogether, as the current decreases.

If using a primary battery without an ammeter, resistance may be shunted when the current has been flowing for ten minutes.

Before leaving the subject of primary batteries, we may say that if a reliable agent is fairly near, we should make use of him rather than charge at home, unless a lighting circuit is convenient. We always have a primary battery at hand, however, and this we keep filled with water to preserve the porous pots in good condition. Large bottles of the necessary solutions in this case are kept ready mixed, so that the battery may be ready for use at a few moments' notice.

Charging through Lamps as a Resistance.

389 The method of charging through lamps is very generally used, both on account of its simplicity and of its low first cost. As we have said, the actual working expenses are independent of the number of accumulators charged at any one time, and unless this is properly understood, the method is an extravagant one.

A charging board should be so designed as to allow of any current from 3 ampères to ½ ampère being passed.

The actual rate employed for 30-ampère-hour accumulators may be 2 ampères, but when it is necessary to charge quickly 3 ampères may be used; but when a cell has been accidentally completely run down, or has in some way got out of condition, a very slow rate of charge—½ to 1 ampère—is best.

Taking the case of mains at 100 volts, we have seen that a 32 c.p. lamp takes 1 to 1.2 ampères, and a 16 c.p. lamp .5 to .6 ampère.

If we fit a charging board with three lamps—that is, with two 32 c.p. and one 16 c.p.—the maximum current when all three lamps are lighted will be about 2.8 or 3 ampères.

For general use, one 32 c.p. and one 16 c.p. passing about 1.7 ampères, or two 32 c.p. passing about 2.2 ampères, may be fitted; while a cell in bad condition may be charged through one 32 c.p. or even one 16 c.p. lamp.

To meet all these requirements, we must design a board taking three lampholders, and suitable terminals for connecting up the accumulators.

It will also be handy to fit a switch with a "cut-out" or "fuse" in case of any accidental short circuit, and for convenience when connecting up.

The system of wiring employed is shown in fig. 4. W P is a wall plug, or an adapter, which may be fitted in the place of any convenient lamp. From this point wires pass to the switch S and the terminal T^1. When the switch

is on, connection is made through the fuse F to the lamp wires. This wire is looped into the lamps L^1 and L^2, and terminates at the lamp L^3. · From the three lamps three separate wires pass back to the terminal T^2, and the circuit is completed when accumulators are connected up between the terminals.

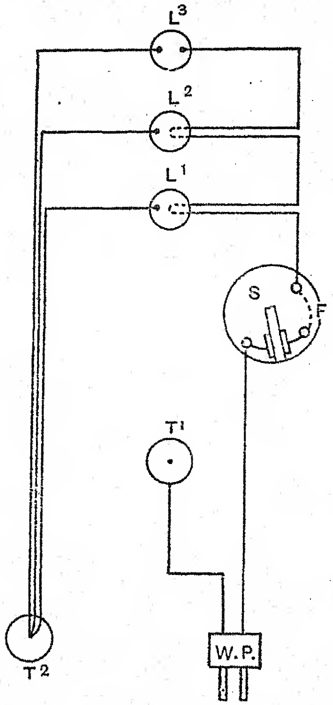


FIG. 4.—DIAGRAM OF WIRING FOR CHARGING THROUGH LAMPS.

F, fuse wire in switch.
L^1 L^2 L^3, lamps.
S, switch.
T^1 T^2, terminals to which the accumulator is connected.
W P, wall plug.

A convenient arrangement of lamps, terminals, and switches is that shown in fig. 5. This will necessitate a slight alteration in the arrangement, but not in the principle of the wiring.

In a ¼in. mahogany or oak board large holes should be bored in the positions of the lamps and switch, so that the wires may easily be passed through from the back. The wiring is, of course, all done at the back of the board. This is shown in fig. 5.

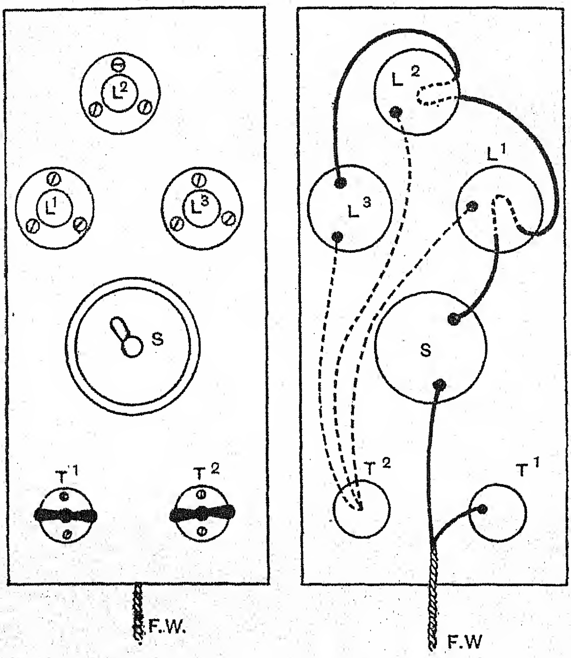


FIG. 5.—FRONT VIEW OF CHARGING BOARD. REAR VIEW OF CHARGING BOARD.
L^1 L^2 L^3, lamps. T^1 T^2, terminals.
S, switch. F W, flexible wire.

The flexible wire from the plug, or adapter, is brought in through a groove; the insulation of the last inch is removed, and the two bared ends are connected to T^1 and S. The wire is then connected to the other terminal of S and passes to L^1, where an inch or so is bared and connected up. The wire passes on to L^2, where it is again "looped in," and the bared end is finally connected at L3. The remaining terminals of the lamp are connected by the wires, shown dotted, to the terminal T^2.

Pole Finding and Connections.

390 It is quite likely that some who are not versed in electrical matters may be unduly impressed by the directions so often repeated as to the correct method of connecting up accumulators in circuit.

This matter, in reality, presents no difficulty. We know that when an accumulator is in use the current flows from the positive pole, through the external circuit, to the negative pole. Evidently, then, when charging, the opposite direction of the flow must be correct. That is, the positive of the accumulator must be connected to the positive of the supply. In a primary battery *the carbon is the positive*, and, therefore, is connected to the red terminal of the accumulator, the zinc being connected to the black terminal. When several accumulators are charged at the same time, they are connected in series; that is, the negative of the first is connected to the positive of the second, and so on.

When charging from a lighting circuit, we must adopt some method of finding out which is the positive of the supply. The most usual plan is by means of pole-finding paper, of which there are two or three kinds. But when these are not at hand there are one or two other simple methods which can be employed. If the terminals of the charging board described previously be connected by a straight wire, and a compass placed below the wire, the needle will be deflected when the current is switched on.

It is best to place the wire in a north and south direction. Then stand at one end, looking along the wire, and switch on the current. If the north pole of the compass needle is deflected toward your left hand, the pole nearest to you is the positive; if toward right, the far pole is the negative.

Perhaps the simplest method of all is to connect the accumulator up, first one way and then the other, though this is not recommended. It will be noticed that in one case the lamp burns more brightly than in the other. When the light burns rather feebly, the accumulator is taking some of the power, and is being charged. When the light burns more brightly, the accumulator is helping the main supply, and is discharging itself. The latter connection, therefore, is wrong.

The effect on the light when only one accumulator is connected up, though quite perceptible, is small. This leads us, naturally, to the idea that it would be well to charge through lamps which would in any case be in use, this method involving no loss of power.

Lighting and Charging.

391 We will take the case of, say, a motor house lighted by electricity. This would be convenient, as when the lights are in use it would generally mean that a competent man was in the building. The ideal arrangement, of course, would

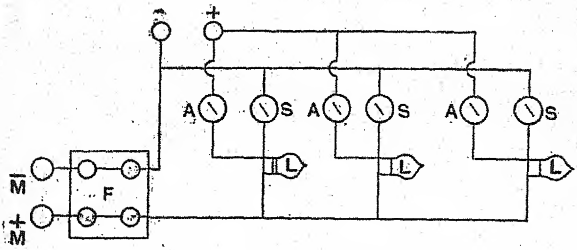


FIG. 6.—LIGHTING AND CHARGING WIRING DIAGRAM.
A A A, accumulator and lamp switches.
F, fuse or cut-out.
L L L, lamps.
Mains connected to M+ and M—.
S S S, ordinary lamp switches.
+ connected to positive and — to negative poles of accumulator.

be one which would allow of the accumulator being charged at any rate from one-half to three ampères without taking out any lamps when the lower rates of charge are used, since all the lamps may be needed for lighting the building.

A diagram of the wiring necessary to effect this is given in fig. 6. It will be noticed that two switches are used to

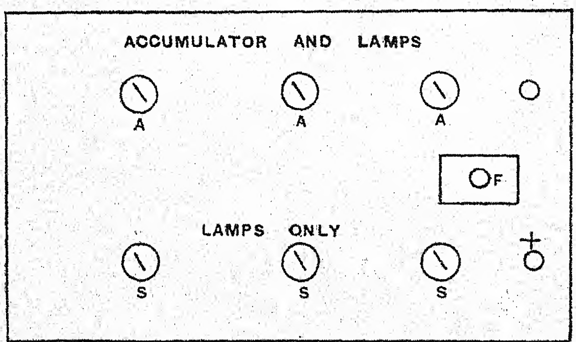


FIG. 7.—SWITCH BOARD FOR LIGHTING AND CHARGING.
A A A, accumulator and lamp switches. S S S, ordinary lamp switches.

each lamp. Other arrangements, such as two-way switches, might be equally effective. The method given, however, is quite straightforward, and would cost but little. The switches might be arranged as shown in fig. 7. When the lamps are used for lighting only, the three lower switches would be on, those on the top being off. To charge at half an ampère, the left-hand lower switch would be off, and after connecting up the accumulator, the upper left-hand switch would be put on. Similarly, to charge at three ampères, all those on the top would be on, those on the bottom being off. It would be well, especially on a 220-volt circuit, to keep the accumulator switches off until the cells are connected up, to avoid any chance of a slight shock. A fuse box should also be fitted.

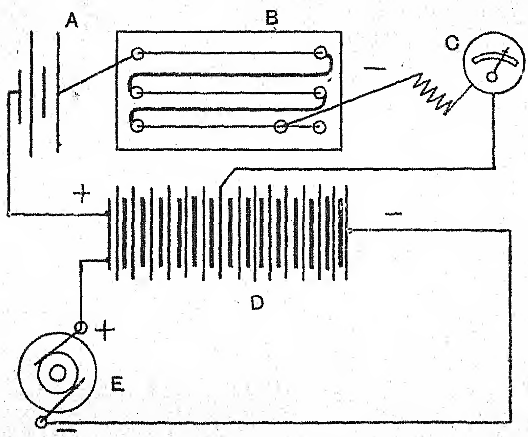
If this system is used, it is best to charge the accumulators singly, as two or three in series would affect the lighting of the room considerably. The cost of this method is practically *nil*, and when once the wiring is complete, there is no further trouble in finding the poles or in any other way.

The actual wiring must vary with different conditions, and consequently cannot be fully described here. We should strongly advise all who are having new motor-houses built, or any wiring done in their buildings, to provide for this method.

Charging Accumulators from an Electric Light Plant.

392. One or more motor car accumulators can be charged from an electric lighting plant at the same time that the ordinary lights are in use, and the cheapest method to employ is to fit up the circuit as shown in the diagram. In the ordinary way the dynamo supplies current to the storage cells, and current may be tapped from one or any number of the cells—provided that they have current in them—whether the dynamo be running or not. It is only necessary to connect one of the positive plates of the cells, say the end one, to the positive pole of the accumulator to be charged; the other pole of the accumulator, which is the negative, should then be connected through a resistance and a small ammeter to the negative pole of one of the electric light accumulators. As shown in the sketch, a four-volt car accumulator is connected in circuit with three of the storage cells, and as each of these cells, when fully charged, indicates or gives an electrical pressure of 2.2 volts, it follows that there will be an effective pressure of rather over 2.2 volts acting against the lower pressure of the two accumulators being charged, and thus a current will be forced through them. Unless a resistance be used, more current will probably be forced through the car accumulators

than is advisable; hence the necessity for a resistance board and also a small ammeter to register exactly the current being charged into the car accumulator. Under the conditions shown in the sketch, about two yards of German silver wire of 24 Birmingham Wire Gauge are sufficient, each yard of this wire at normal temperature having a resistance of about .93 ohm. The resistance board can be made very cheaply with the German silver wire, as the latter can be obtained from practically any electrical stores. A piece of dry board should be used, with brass sprigs driven into it,



Method of wiring car accumulators to storage battery.
A, car accumulator. B, resistance board. C, ammeter.
D, storage accumulators. E, Dynamo.

so that a wire from the accumulator can be connected to one sprig, and then the German silver wire wound round the first sprig and crosswise, as shown, round others, simply stretching the wire as on a tuning board. The ends of the wire can be wrapped several times round the last sprig so as to secure it firmly to the board. Then a wire from the negative pole on the accumulators should be connected to the ammeter, and from the other terminal of the ammeter a flexible wire will be required, so that connection can be made at any part of the German silver wire stretched over the resistance board. The said wire makes the electrical connection, and no switch is required. By making connection at some point of the resistance wires the ammeter will indicate the amount of

current passing through the car accumulators, and the nearer the wire from the ammeter is connected up to the sprig attached to the car accumulator wire, so the resistance in the circuit is decreased, and can, in fact, be cut out altogether by joining the ammeter wire to the last sprig nearest the car accumulator. By sliding the wire along the resistance board, the current passing through the accumulators can be adjusted to a nicety. Instructions are usually put on motor car accumulators, which give the current rate it is desirable to charge at, and this in no case should be exceeded, otherwise damage may be done to the plates. If more than one 4.4 volt accumulator is to be charged, it is only necessary to vary the connection from the negative pole of the electric light accumulator to the ammeter, taking in, say, two more cells for each extra car accumulator of 4.4 volts. Thus there is always one cell more than those under charge, which is sufficient to force enough current through the car accumulator.

It should be noted that in cell charging it is always necessary to connect the positive terminal of the charging cells to the positive terminal of the cell being charged, and *vice versa*.

Charging from an Alternating Circuit.

393 For agents who live in towns where the electric supply is an alternating one, and for hotel keepers and others, an aluminium rectifier should be of considerable use. The rectifier consists of four cells, each containing a lead plate and an aluminium rod, immersed in ammonium phosphate. Owing to the peculiar properties of aluminium, these cells act as an electrical valve, opening to allow the current to flow in one direction, but closing when a reverse current attempts to flow. By this means an alternating current can be so rectified that it can be used for charging accumulators. The rectifier is inexpensive and easy to use. The treatment required is somewhat the same as that needed for a primary battery, but the chemicals and aluminium rods only want renewing about once in three months, and the lead plates are practically everlasting. The ammonium phosphate should be dissolved in distilled water, and not in ordinary tap water.

Another method is to employ an alternating current motor to drive a small continuous current dynamo. The alternating current wire is connected up to the motor which it drives, the motor in turn driving the dynamo to which it is coupled. The accumulators are then connected up in the usual manner to the wires conveying the current from

the driven dynamo. A combined alternating motor and continuous current dynamo can now be bought in a compact and convenient form.

When to Charge up Accumulators.

394 When the usually deep chocolate-coloured positive plate of an accumulator begins to look as though a very fine sprinkling of flour has been made on its surface, then it should be tested. Usually, when this condition is presented, a four-volt battery will register 3.8 volts on the voltmeter, and it is not safe to risk running longer, but the battery should immediately be recharged, and care taken that the plates are completely covered with acid.

Charging Accumulators on High Voltage Circuit.

395 Car owners occasionally inform us that their accumulators have been burnt up whilst charging on 200 or 220 volt lighting circuits, and we think it would be of general interest to call attention to the probable reason for this, which is not excessive current passing through the battery itself, but a leak to earth through a film of acid on the case. This will sometimes generate sufficient heat to ignite the celluloid, with disastrous results. The remedy simply is to stand the accumulators whilst charging on a board which rests on glass jam jars as insulators, and keep the top of the accumulators as dry as possible.—C. A. VANDERVELL AND CO.

WHAT TO DO WITH A NEW CAR.

INTRODUCTION. — POSITION OF IGNITION AND THROTTLE LEVERS.—AUXILIARY AIR ADJUSTMENT.—IF THE ENGINE WILL NOT START.—SUGGESTED ADJUSTMENTS.—THE ENGINE STARTED.—THE LUBRICATION SYSTEM.—GENERAL LUBRICATION.—DELAY ENCOURAGES FORMATION OF RUST.—GRAVITY-FED PETROL.—PRESSURE FEED.—TYRES.—WHEELS.—WHEEL-LOCKING DEVICES.—STEERING JOINTS AND BRAKES.—GENERALLY.

Introduction.

396 "How absurd!" I hear some reader say. "Why there is nothing to be done, except perhaps to see that there is petrol in the tank and oil in the engine, and then—away for a trial run!" I cannot agree. I admit that I thought the same at one time as the reader quoted above, but dearly I paid on one occasion when I took delivery of a new car for being so certain that I knew all there was to be known of my most recent purchase. It is not necessary for me to enter into all the details of that experience—for I blush even yet to think of my carelessness—but suffice it to say that before I covered fifty miles of a trial run one big end bearing of the engine had melted. I thought—Oh, why did I not make sure?—that I was giving the engine plenty of oil; but I had not been careful enough when examining the working of a three-way tap, and the oil that should have gone into the engine had found its way into the gear box! However, that happened some years ago, and I—well, I hope so—have become wiser since that time. I purpose, therefore, setting forth, for the benefit of the uninitiated primarily, the procedure which it is advisable to follow when that new car has arrived at last, and is at our service.

All of us are not able, by reason of the "depth of our pockets" perhaps, to take advantage of the willingness of the makers, or "concessionnaires," to supply an experienced instructor or driver for a week or two, to show us the ins and outs of the car, and it may be that if we have obtained the car through a local agent the latter may not know much more of this latest model than we do ourselves. It may have been delivered by one of the maker's drivers, but even then we were so excited at taking delivery and with the intoxicating effect of a short run that we did not really take notice of the

position of the various levers when the man started the engine, nor of other essentials; or, maybe, having come by train, the car is waiting at a railway station for us to take delivery there. We have driven a motor before perhaps, but we know practically nothing of this make or model. We are left to our own resources, anxious to do the right thing to prepare for a run to-morrow, so that there shall be no risk of our being in difficulties, or innocently causing damage on that auspicious occasion. What shall we do first? In order that we shall have the satisfaction of afterwards knowing we can do it, I suggest that we start the engine and run it for a few minutes.

Position of Ignition and Throttle Levers.

397 The first thing to ascertain is the correct position of the ignition and throttle levers for starting easily and without fear of back fire. Take the former first. How shall we ascertain at which end of the quadrant the lever should be when the ignition is fully retarded? We must first find the low tension contact maker of the magneto, or accumulator system if only the latter be fitted. Remove the cover, then turn the engine slowly by the starting handle, noting carefully the direction in which the contact maker arm revolves—that is, clockwise or contra-clockwise. Bearing this in mind, we next find out which one of the levers on the steering wheel or column moves the contact maker casing, and if we previously noticed that the contact maker arm revolved clockwise the casing should also be moved clockwise to its limit of movement to obtain the full retardation of the ignition. And *vice versa*.

In some ignition devices the movement of the lever has effect upon the actual contact maker arm, and not upon the case—this applying to some of both magneto and accumulator ignitions. If this be so on our car and the engine move the arm clockwise, we must, to obtain the full retarding movement, manipulate the lever so that the arm turns contra-clockwise. Therefore, if the hand lever move the case, actuate the latter, to retard, in the *same* direction as the ignition spindle revolves; but if the hand lever partially rotate the spindle or contact arm, actuate the one or the other in the *opposite* direction to that in which it is turned by the engine for the same purpose. So, then, we have found out at which end of the quadrant the hand lever should be placed to retard. Leave it at that point for the present.

The next matter is in connection with the throttle. Can we readily ascertain at which position of the hand lever the

throttle is open ? We do not want to take the carburetter to pieces, and we cannot tell by looking at the outside of it, so unless the quadrant on the wheel is marked in some way, I suggest a plan which I have found successful in starting strange cars, viz., set the throttle lever at its halfway position—at a point which is the centre of its movement along the quadrant.

There are other levers which will require attention before we attempt to start the engine. The change speed lever is one of these. If a gate change be fitted, there will be no difficulty in ascertaining the neutral position and setting the lever there. But if the gear change be a straight-run-through type, *i.e.*, all the gear notches on one quadrant, we shall probably find the neutral position to be when the lever is engaged in the most rearward notch but one. At the same time, we shall make certain of the correct position whether the change is by the gate or otherwise, by setting the lever at the point we imagine to be neutral, and then turning the engine with the ignition switched off. If we can move the engine even a quarter of a revolution without the car moving, too, we have been correct in our surmise, and the lever is in neutral.

Auxiliary Air Adjustment.

398 Then there is the side brake lever. "Oh, how unnecessary to mention that the side brake should be on before starting," I hear that before-mentioned reader saying. It *is* obvious undoubtedly, but, nevertheless, it is often forgotten, and if the car be on a gradient and the vibration set up by turning the engine cause the car to commence running backward or forward, it is disconcerting, to say the least, to be compelled to rush wildly at the brake lever and apply it in such an emergency. So we will put the brake hard on. Is there an auxiliary hand-operated air lever fitted ? If so, it will be advisable to move it to a point where the air inlet is closed. This point can easily be ascertained by examining the inlet itself, for in all probability it will be within view. If it be enclosed at a point in the length of an air inlet pipe, so that we cannot see when it is open or shut, which is most unlikely, we must proceed for the time being as with the throttle, and set the lever halfway. After suggesting that we make certain there is some petrol in the tank, I might pass over the next item by merely saying, if the supply be gravity fed (I will refer to pressure fed petrol systems later), "turn on the petrol." But sometimes one cannot be sure at the first attempt how the tap should be placed to allow petrol to pass to the carburetter. Therefore, set the tap parallel to the

supply pipe and attempt to flood the carburetter to such an extent that the petrol can be seen to overflow. If success in this respect be not met with, turn the tap so that it is at right angles to the supply pipe, and try once more to flood the carburetter. No, do *not* shake the needle valve up and down so vigorously; you will attain the desired end much sooner and with no liability of making the float leak if you merely lift the valve spindle away from its seating and hold it so for a few seconds. The carburetter is flooding. Well, before switching on the ignition we should give the engine three or four vigorous turns with the levers set as advised, viz., ignition retarded, throttle at midway position, auxiliary air (if fitted) closed, gear lever neutral position, and side brake hard on. Those few turns of the engine with the ignition off give us an opportunity of feeling the engine, of becoming accustomed to the operation without danger of a back-fire, and at the same time it is more than likely that a good rich mixture will be drawn into the engine ready for firing at the first turn when we seriously attempt to start. The preliminary turns having been accomplished, we will now have a serious attempt to start the engine. We may have been accustomed to "swing" the engine of our old car, but it will be advisable to refrain from doing so with this new one until we are sure of the setting of the ignition, or find it impossible to start otherwise. So, after switching on, we will merely pull the engine over each compression in turn. Note that I have said "pull"; don't push the handle down. This latter is a bad, very bad, plan even when adopted with an engine the timing of which is a "known quantity." Engage the starting handle with its clutch at a point where the upward movement of the handle is just commencing, and then pull up smartly.

If the Engine will not Start.

399 If we have set the various levers approximately in their correct position for the purpose the engine will doubtless start at the first pull over, but if half a dozen efforts fail to accomplish that end, it can be taken for granted that something is amiss with our various adjustments. We shall probably be merely wasting time by endless attempts to start as things are, so some alteration must be made. What variation shall we make first? If there be an automatic air valve fitted which is readily accessible, I advise that this receive attention, for the greatest probability is that the mixture entering the engine is weak, and to remedy this we may by any

available or convenient makeshift prevent the valve from coming into action at all—by tying a piece of cloth or fixing a leather strap round or over the air inlets of the device, for instance. This done, we can try another half-dozen turns of the starting handle, and, if successful, remove the cloth immediately and—well, what to do then will be told later. (See "The Engine Started" No. 401.)

But supposing the engine does not start even then, there are quite a number of possible and reasonable adjustments which may be made before we should become disheartened. It is an undeniable fact that some engines—their carburetters usually being the offending details—will not start when cold unless the levers are placed "just so," and if our engine be one of these, it is merely a matter of making a few experiments before we shall hit upon the correct position. In order to save time and space, I will set out concisely hereunder the various and not unreasonable setting of the levers and means which may be adopted other than that already mentioned to attain the desired end.

Suggested Adjustments.

400 Assuming, as is the more likely, that the mixture is weak :

1. Close the throttle slightly by moving the lever towards one end or the other of the quadrant.
2. Flood the carburetter excessively.
3. Inject petrol into the cylinders by way of the compression taps or through the sparking plug orifices.
4. Advance the ignition slightly, being even more careful than before to pull the handle *up* with the four fingers only encircling the handle grip and the thumb clear, so that the grip may be released naturally and readily in the event of a back-fire.

Finally, assuming that the mixture is too rich and with the throttle in the midway position :

1. Refrain from flooding the carburetter, and wait a few moments until the surplus petrol has run off.
2. Open auxiliary air inlet slightly, if fitted.

And now I think we have exhausted all reasonable possibilities to which the obstinate starting may be due. It is very unlikely that the engine will still be at rest if all the foregoing adjustments, separately and combinations of them, have been tested. It will have been helpful if we have prior to each attempt switched off the ignition and given the engine

a few more of those vigorous turns which I have mentioned as being so helpful towards inducing a good firing charge into the engine. Something must be out of order, the setting right of which is apart from the scope of this article, or the engine must be a very bad sample of the obstinate type if it has not been started long ago.

The Engine Started.

401 Assuming that we have managed to start the engine, we shall probably find it necessary in the first place to advance the ignition slightly to keep it running, and then to close the throttle to prevent racing, which will be sure to occur with the throttle halfway open when the engine has picked up its stride. But do not forget that you are probably uncertain which are the closed and open positions of the lever setting. So in moving the lever do not hesitate, if the effect of moving it in one direction be other than that which is required, to move it back in the opposite direction. Such hesitation will possibly bring the engine to rest once more, and necessitate all the trouble of starting it again before you have really had time to notice the setting of the various levers which enabled you to start in the first place. At the same time, it will be of advantage later on if the ignition, throttle, and air levers be manipulated by way of experiment during the two or three minutes which the engine may be kept running on this first occasion, for it will enable us to learn the effect of the various movements. For instance, the throttle of one car may be very sensitive and require a finely graded movement to open it considerably. On the other hand, exactly the reverse may be the case—a considerable travel of the lever may open the throttle quite a small amount —and, anyhow, we must learn these varying effects, so why not at once? Do not keep the engine running too long. I want to talk about other matters which must or should be attended to very early with a new car.

The Lubrication System.

402 The item of the design of the car which should be carefully considered without further delay is the lubricating system of the engine. In the cars being manufactured and in use at the present time, the various systems are numerous beyond account, but practically all of them may be considered as coming under one or the other of the following heads:

1. Mechanical. 2. Drip-fed splash.

When ordering your new car you will, I have very little doubt, have enquired of the maker's representative or agent as to what system of lubrication is fitted. But in case you have not done so, and cannot gain the information from the catalogue issued by the makers, it may be said that, roughly, if any form of indicator or pressure gauge be fitted in the circuit of the oil pipes, and such as will show movement when the engine is running, it may be taken that the lubrication comes into the first category; but if no indicator be fitted, and the only visible signs are drip feed glasses on the dashboard which are only effected by hand adjustment, or when only an oil pump worked by hand and situated on the dashboard is fitted, it can safely be concluded that the second type referred to has been adopted.

MECHANICAL LUBRICATION.

In this category may be included systems where the oil is supplied to all the journal, big end, and gudgeon pin bearings, as well as pistons and cylinders, by pressure generated by a mechanical pump, from which the oil is led to all the parts mentioned by pipes and passages—that is to say, where no provision is made for the connecting rod ends to dip into the oil and scoop it or throw it on to other moving parts. Then there is the system sometimes called semi-mechanical, in which the oil is carried in pipes or ducts to some only of the parts mentioned, and which embodies a series of trays placed under the connecting rods, a constant level of oil being kept in these trays by a supply from the pump, in order that scoops fitted to the big end caps may dip into the oil, and by splash supply it to the various parts not in direct connection with the pressure pipes.

There are modifications of both these systems, but for our purpose they may be considered the same. All variations are, or should be, fitted with an oil-filling pipe near or attached to the crank chamber casting, also some form of overflow pipe or indicator, by means of which it can be known when sufficient oil has been put into the well or sump at the bottom of the crank chamber.

Therefore, find this oil filling pipe and the overflow or level indicator, and charge the engine with the lubricating medium until it overflows or reaches the desired level at the indicator. If the system be in order, as, of course, it should be on a new car, we need worry no more on the score of the engine lubrication, except to note that the gauge or other device provided on the dashboard indicates that the oil is circulating. It is quite impossible to deal here with the various

means provided for this latter purpose, but it is well to bear in mind that until we are sure of the requirements of the engine it is safer to give an excess of oil, represented by the pressure, than not enough.

Drip-fed Splash.

In this division may be included the splash system of lubrication where the oil is supplied to the crank chamber at certain periods by a hand pump worked by the driver, in addition to the system where drips only are fitted. It is one of the great failings of the drip and pump feed systems that in the majority of engines so fitted no provision is made to indicate when enough oil has been put into the engine before starting out, nor is it possible without experience of each individual car to know whether a correct supply is being given to maintain the most desirable level.

By hook or by crook we must first ascertain how much oil there is in the crank chamber. Usually some form of inspection plate is fitted, and if this be in position on our car it must be removed, so that we can see whether the connecting rod ends are actually dipping into the oil at the lowest point of their movement. The lowest part of the connecting rod or bolts attached thereto should be submerged in the oil to a depth of about ¾in. when the engine is stationary.

But supposing no inspection plate be fitted. We must in that case pour oil into the crank chamber by any available passage or opening, or even by setting the drips to run very freely, and continue to supply in this way until a suggestion of smoke is apparent from the exhaust when the engine is running freely at 500 r.p.m., we will say. It will be as well, too, if for a few days we make a practice of running the car with this faint suggestion of smoke. We shall be gradually able to judge, as experience is gained, at what speed the drips should work to enable only a small amount of smoke to be seen, but after the first 250 miles or so we can commence to cut down the supply slightly. At this period the number of drips of oil per minute in an engine of about 12 h.p. should be in the neighbourhood of fifteen to twenty.

On the subject of engine lubrication generally, it is distinctly advisable to run out the old oil and recharge with new after the car has been run about 250 miles, and again at 500 and 1,000. Probably a drain tap at the bottom of the crank chamber or oil sump is fitted for this purpose. If not, it is very unlikely that some form of screwed plug will not be found. When the old oil has been drained away, it will be well to flush the system through with a pint or so of paraffin. In new

engines it will be found more often than not that the first two or three charges of oil will drain out showing signs of dirt, and sometimes even steel and aluminium filings, so that, especially in pressure systems, these first two or three wash-outs are of great importance.

General Lubrication.

403 Having considered the lubrication of the engine, it will be good policy to give attention at once to the other parts of the car where lubrication is essential. The gear box is one of these, and here it is merely a question of ascertaining whether there be sufficient oil therein by opening the inspection lid and peering inside. The level of the oil should not be lower than the centre line of the lower shaft, and in a new car I should certainly advise that oil slightly thinner than is usually supplied for gear boxes should be used, in order that there may be no doubt of the oil penetrating to the furthest extremities of the bearings, which, having had practically no wear, are likely to be on the tight side.

The clutch is another detail requiring attention immediately, especially so if this be of the multiple-plate type. As a rule, the same kind of oil that is used in the engine can be used for a plate clutch. Here, again, it will be well if, after driving the car 500 miles or so, we empty all the oil out, rinse through with paraffin, and charge the clutch with new oil.

If the clutch be of the ordinary leather cone type, we should at once ascertain what means are provided for lubricating the spigot bearing on the crankshaft end. This is a bearing which is overlooked very often, but, as a matter of fact, it is one of those points to which close attention should be given, for any sign of stiffness or seizing at this point causes a considerable amount of difficulty in changing gear, and, as can be understood, this applies to a formidable extent in the case of a car strange to the driver. The usual means provided is a grease cup fitted to the clutch member, but sometimes merely an oil way will be found, and in some extreme cases, showing great want of thought on the part of the designer, no actual provision for lubrication is made at all. In this case the clutch pedal should be depressed and an oilcan with a long spout used, so that oil may be delivered through the arms of the clutch directly on to the spigot of the crankshaft.

The live back axle should next receive our attention. To be on the safe side and to ensure that plenty of oil be therein, it will be well to put at least a quart, but preferably

half a gallon, of thick oil into the axle casing. This part of the anatomy of the car is a third point from where the oil should be drained out after a short use. Personally, and particularly in the case of a worm drive, I should drain out any oil therein immediately the car was delivered to me, flushing the casing out with at least half a gallon of paraffin, spinning the back wheels the while after jacking them up, in order that the whole of the interior might be thoroughly cleansed, after which I should pour in a gallon of thick-bodied oil.

One never knows what amount of care may have been spent in assembling back axles, gear boxes, and engines to ensure that no dust or filings have entered, and I have seen some instances of gross carelessness in this respect—so much so that I should never hesitate to drain out the oil from all three parts before taking my first long run.

Then as to the lubrication of the wheels. These in a modern car will probably run on ball or roller bearings, and unless some special means are provided by the designer it is a safe plan to insert the lubricating medium by removing the wheel caps and charging the hubs with a semi-liquid mixture of oil and grease.

There are, of course, numerous points on the car fitted with grease cups and lubricators with which we must become acquainted, and the policy of some drivers and owners of neglecting the small points during the first month or six weeks' running of a new car, on the assumption that these parts have received close attention from the manufacturers, is to be deprecated. In the first place, many of these points may not have been thoroughly greased or oiled in the course of erection, in which case the month's running may allow rust to form to such an extent that it will be impossible to insert oil or grease without taking the detail apart.

Delay Encourages Formation of Rust.

404 The bolts of spring shackles, for instance, will become thickly coated with rust after a few hundred miles running if at the commencement of that time they have not been thoroughly lubricated.

So, before we have had the car in our possession many hours, it will be advisable to "run over" all these lubricators and grease cups, and supply them with the correct lubricating medium. I would suggest that prospective owners should obtain particulars of the lubricating system of their car-to-be by applying to the makers for full details before the car is delivered, so that these may be studied at leisure.

Gravity-fed Petrol.

405 There is not much to find out or attend to in connection with the petrol supply of a new car if the feed be by gravity. I have referred earlier in this article to the matter of ascertaining the correct "on" and "off" positions of the supply tap, but perhaps a further note in that connection may be called for. I refer to the possibility of the tap becoming "on" or "off" of its own accord through vibration, and it is quite a simple matter to make sure that the locking nut on the tap, if fitted, is tight or secure. I have experienced *un mauvais quart d'heure* on more than one occasion, attempting to find the cause of a comparatively sudden stop on the road, which was eventually traced to the petrol tap, this having been shut off by vibration.

A spell of more or less serious misfiring may be brought about by the same thing happening to a partial degree—the tap becoming half on and half off, causing the engine to be starved of fuel at moderate and high engine speeds.

Pressure Feed.

406 A pressure-fed system of petrol supply in a new car may cause a certain amount of consideration beyond that of the other type, but there is no feature which cannot be mastered by the expenditure of a little care in examining the various details.

In the first place the "filler cap" should be examined, for this should have a snugly fitting leather washer by means of which an air-tight joint can be made at this point. After using the hand pressure pump, usually situated on the dashboard, to cause an air pressure of, roughly, 2 lbs. in the tank (if no gauge be fitted, eighteen or twenty strokes of the pump should have the desired effect), an attempt may be made to flood the carburetter, although it is quite possible that a petrol tap may be inserted in the system at one point or another, and this may require an obvious manipulation.

If difficulty be found in obtaining or maintaining pressure in the petrol tank, the various unions and joints in the piping must be examined, and also the automatic pressure valve—situated on a branch from the exhaust pipe most probably, although on several well-known cars it is now worked mechanically by the engine. These exhaust pressure valves have an awkward habit of leaking until they settle down to their work, but if the "mushroom" be lifted from or turned on its seating, or if a small quantity of petrol be squirted with an oilcan into and through the valve, the leak is usually stopped.

When searching for leaks in a petrol pressure system a good plan is to smother the joints with lubricating oil, so that, at the source of the leak, bubbles of the oil can be seen, and the trouble located prior to tightening up the joint.

Usually in these pressure systems some form of "water trap" is fitted, the object of which is to collect the water formed in the pipes by condensation of the hot exhaust gases. It will be well to examine this almost immediately, for if an excess of water occur in this device the overflow will be forced into the petrol tank, and water in the petrol tank is, as my readers one and all are probably aware, a matter to be avoided by every possible precaution.

The petrol filter is the last item to which I wish to refer, and this is often a source of a great deal of unnecessary trouble on a new car. In the process of making the petrol tank it has been found that dirt and loose pieces of solder or brass only too often remain inside, and quickly find their way to the filter on both pressure and gravity systems. So, commencing on the first day and at periods of a week or so for the first month—depending, of course, on the amount of use to which the car is put—I advise that the filter be taken to pieces and cleaned thoroughly.

Tyres.

407 The attention which should be given to the tyres of a new car is not very considerable. It will not be amiss, however, to note whether the security bolts will bear tightening and whether they be correctly fitted—that is, of course, standing through the rim a similar and generous distance. The air pressure in the tyres should be tested, obviously, and this should be between 60 lbs. and 100 lbs. per square inch, varying according to the weight of the car and load, and whether on back or front wheels. The table of tyre pressures issued by practically all the tyre makers may be taken as a guide, although I have found that the pressures generally recommended are on the high side by 5 to 10 lbs. when comfort is borne in mind as well as other considerations. I need hardly suggest that one will make certain before taking the first long run that a pump, jack, and other details of tyre repair and removal equipment are on board the car.

Wheels.

408 Writing of tyre repairs brings one to the subject of spare wheels, detachable rims, and detachable wheels. If one or the other of these most desirable features have been fitted or provided, it is well worth while to make

a trial of the fitting and removal of the device before venturing far from home. A great deal of time and even anxiety may be saved by so doing, for away from the garage on the roadside, maybe after dark, the first attempt to make use of one of these time-savers in a case of necessity may involve a considerable amount of delay by reason of one not being quite *au fait* with the easiest and correct method of manipulation.

It may not be out of place to put forth a warning to those who have not previously used and handled detachable wheels. When a car is jacked up and the wheel removed, there is a possibility of a great deal of damage being done if the jack be not firmly planted and the wheels scotched, or the brake applied, when a front wheel is being changed, for if the car should run off the jack it is not merely a matter, as of old, of the wheel with the dismantled tyre dropping on to the roadway, but, the entire wheel having been removed, the car at that corner will drop fifteen to eighteen inches perhaps, down on to the axle end. Apart from the difficulty which must ensue in the matter of raising it on to the jack again, the question of possible damage is a serious one. It is more than probable—almost certain—that a bent axle will be the result.

So in jacking up a car to remove a detachable wheel ensure that the ground on which it stands is approximately level in all directions. If the ground slope in one direction, it is far better that the car should face up or down the gradient than that it should be out of the perpendicular to one side or the other.

I am afraid that this consideration has not yet been forced upon the makers of jacks, for these are still being made, as far as my knowledge goes, with the same base as of old, viz., about eight or nine inches in diameter. There are occasions when it is almost impossible to avoid removing a wheel when the car is out of the perpendicular—on the camber of a narrow road, for instance—and with a jack of the average type there is then a decided element of risk in the operation. A good hearty pull or push in the operation of removing or fitting a wheel is quite as likely as not to send the car off the jack to one side or the other. This same risk is present to a lesser extent when the car is on a level surface, and great care is required even then not to upset the car.

I should advise that, where no safeguard can be imposed on a road with noticeable camber, the car should be taken before operations are commenced to that side of the road which will cause the wheel to be manipulated to be on the higher ground—that is to say, the undamaged or unpunctured

tyre or the same axle should be in the gutter. In this matter a certain excess of half the weight will be taken on one of the natural "legs" of the car.

Wheel-locking Devices.

409 Whether the changing of wheels be experimented upon or not before the first run, the locking device upon the hub should be examined to see that it is in the locked position. To those who have cars on order or just delivered fitted with detachable wheels of any make, I would recommend that the makers of the wheels be applied to for instructions as to fitting, removal, and locking of their particular type. But, anyhow, do not be satisfied until by some means you are quite certain that the wheels are locked.

Steering Joints and Brakes.

410 The steering joints of a new car should very early in its existence be fitted with leather bags, although a great number of makers supply their cars so fitted. In the latter case the bags should be opened to ascertain whether they contain the necessary grease.

It will usually be found that the brakes are correctly adjusted, but a test of this point will, of course, be made before the car be moved many yards. A test of the "temper" of the brakes should be made on the first run.

Generally.

411 I am afraid the recounting of the several—though they are really comparatively few, when all is said and done—necessary and advisable matters for examination and points for attention on a new car has carried me further than I anticipated when I set out at the beginning of this series of articles, but the owner, present or prospective, of a new car should not be alarmed at the extent or nature of the advice given. One hour (or at the most two) spent in attending to the matters referred to should not be begrudged, for it is more than likely that if slackness and inattention take place at the beginning of the car's existence in its new sphere, numerous troubles, delays, and difficulties will occur later on which might have been avoided.

As a final word I would warn all those who are setting out to drive a new or strange car to "go slow" at first. Even if one have had long experience in driving cars, there is a difference in the design and position of the controlling devices in practically all cars, and this refers to the various models of one manufacturer as well as to entirely different makes.—B.

THE MOTOR HOUSE.

Motor Car Houses in Hot Weather.—A Useful Car Cover.—To Extinguish Ignited Petrol.—The Dimensions of an Inspection Pit.—Inspection Pit Construction.—Preparing for Frost.

Motor Car Houses in Hot Weather.

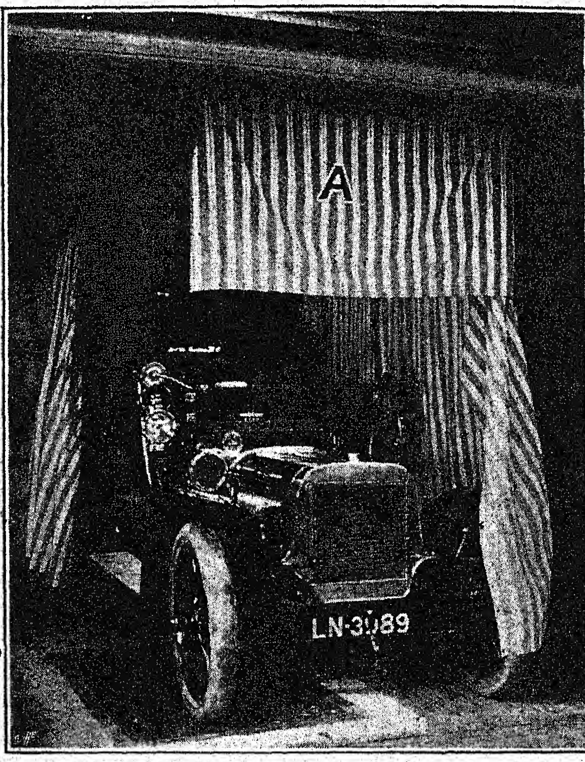
412 Many cars are kept in wooden sheds with galvanised iron roofs and no ceiling. Such sheds reach an absolutely appalling temperature in really hot weather. Those who have to keep their motors under conditions like these cannot do much to mitigate the evil, but what little is possible should certainly be done. In the first place, any windows which face the sun, particularly those which come within its rays between 9 a.m. and 5 p.m., should be shaded. The best plan is to have light shutters made for these windows, or failing these, thick dark curtains. Nothing elaborate is necessary so long as the light is kept out. It will make a very great deal of difference to the temperature of the shed, for in keeping out the light one is also keeping out a great deal of heat, and although the place will get hot, it will be many degrees cooler than if the windows were unshaded, especially if the shutters or curtains be outside the windows.

Another great help is to provide through ventilation—a current of air through the building—but the ventilators must be so placed as to keep out the rain. Here again nothing elaborate is required; small lids with a rough wooden hood or cowl to keep out the wet are all that are necessary. One on each side of the house, preferably north and south, will greatly help to keep down the heat. The differences of temperature which exist on the north and south sides of a building will naturally induce an air current.

The precautions we have indicated are only broadly stated, but they are sufficient to show that quite simple measures will make a very great deal of difference and save much needless perishing of tyres while the car is standing in the shed. Even those who do not care to go to the trouble of providing for ventilation should at least keep out the light, but it is perhaps well to remember that inside blinds or curtains are not nearly so satisfactory as outside shutters for keeping down the temperature of a room. It is also desirable to open the shed every evening so that it may cool down before the next day.

A Useful Car Cover.

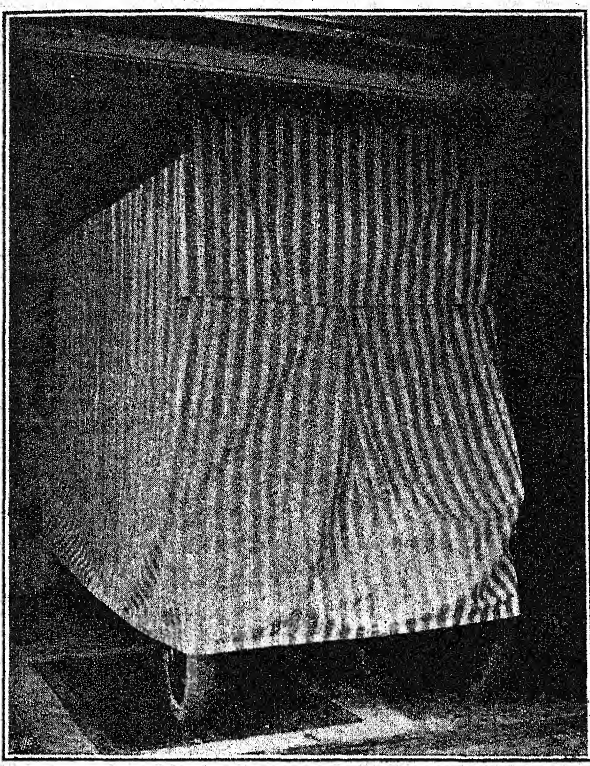
413 It is almost impossible for a man single-handed to cover up a large car of the landaulet type properly without allowing some part of the cover to drag upon the ground, thus making it dirty and perhaps greasy.



The useful cover for covered cars described in the accompanying hint.

A cover which overcomes these difficulties is illustrated herewith. It is made as follows: Two light steel ropes are fixed the length of the motor house, and are made taut with straining hooks at one end. A very light wooden frame is then made the size of the car. This is covered with an

American cloth, and is suspended from the steel rope by four hooks, so allowing the frame to travel the length of the motor house. When the car is driven backward into the garage, the cover can be immediately pushed exactly over it with the aid of a stick. On the underside of the frame light iron



rods are fixed on the two sides and the back, so that the back piece, which is fitted with rings at the top, can be suspended from the rod, and is easily detachable for cleaning at any time. The sides are made like curtains, fitted with rings at the top, and when unfastened are pushed back against the back wall of the motor house; they are buttoned down each side

to the back piece of the cover. The side curtains are made sufficiently wide to come round the bonnet of the car, and are buttoned on to the flap A, which is fixed to the travelling frame. This flap is brought down low enough for a man to button up the cover without using any steps.

The cost for makiug a cover of this description is about the following:

	£	s.	d.
18½ yards 72in. striped blind material ..	2	18	7
6¼ yards leather cloth		14	1
Making up the above	1	15	0
	£5	7	8
Frame rods and steel wires, approximately	2	12	4
	£8	0	0

—H. C. G.

To Extinguish Ignited Petrol.

414 Sand or soil is generally advocated as being of more use than water for this purpose. Anybody who has tried to extinguish flames on a blazing engine with sand realises the difficulty of doing so at all effectively. A better extinguisher would be a hand grenade, and we should like so see a stock of these, at suitable distances apart, fixed on the walls of each public garage, and even in private motor houses.

The Dimensions of an Inspection Pit.

415 The dimensions for an inspection pit for motor cars are as follow: Width of the pit, 3ft. 6in.; depth, 4ft. 6in.; and length, not less than 6ft. A rabbet or ledge about 1in. in width should be left along the edge of the pit, upon which the cover boards may rest when it is not desired to use it. Particular attention should be paid to the drainage, and steps should be provided at one end, if not both. Another useful addition is to nail a piece of 1in. batten along the side of the pit for its entire length, at a height of from 24in. to 30in. from the bottom of the pit. A board resting and sliding upon these battens forms a very handy and movable shelf, upon which one can place the tools, and if made sufficiently strong, it could also be used as a seat for the operator. Where electric light is available, a cable should be laid down to the pit, and two or three wall sockets placed at intervals along the side of the pit, so that one can connect up a portable lamp to the most convenient of these sockets. On no account should

any other light, except a safety lamp of the Davy or miner's type, be used in the pit. Petrol vapour, regarded generally in the light of a gas, is supposed to be lighter than air, and is thought to rise upward rather than accumulate in lower strata. This is not the case, however, as petroleum spirit vapour is heavier than air, and always accumulatés low down. It is always well to see that the hatch or cover is put over the pit when it is not in use, as even a person who knows the premises may, through absent mindedness or sheer carelessness, fall into the pit if it is left uncovered.

Inspection Pit Construction.

416 "May I make one or two suggestions," writes Sir J. H. A. Macdonald, "*apropos* of your useful hint regarding motor pits? In my pit the descent is made by placing a square board about 8in. broad in the corner about 15in. down, then a shelf 1ft. broad running across the end at 18in. down, and then a third corner board lower down on the same side as the top one, but projecting 6in. beyond the line of the centre board. One foot is placed on the top board, the other on the long shelf, and the first foot on the lowest step. The second step makes a convenient shelf for tools, and may be made to slide along battens, as you suggest. This arrangement takes up less room, and is much cheaper, than made steps. As regards lighting, you suggest that wall sockets should be placed along the walls of the pit. It will be found cheaper and much more handy to have the ordinary motor house light provided at the end of a long twin wire, coiled up on a hook. When required in the pit it can be hung over any convenient part of the car below that will light the spot at which work is to be done, or, as I have found convenient, it may be slung round the worker's neck, or hung in front of his shoulder."

Preparing for Frost.

417 Car owners should, when autumn begins to wane, be on the look-out for sharp snaps of frost, especially on fine cloudless nights, as this is where danger of damage to the cylinders and radiators lies. In the case of the more affluent motorist who can afford to fit up the motor house with special warming apparatus, no trouble need be feared, and in some cases a branch pipe can be run with little expense from the greenhouse heating system, or a slow combustion stove be fitted up under a galvanised iron cover immediately outside the house, and the flue taken through it, the products of combustion being expelled where it passes out at the other

side of the building. It is not necessary to obtain a high temperature, for so long as it is kept two or three degrees above freezing point there is no danger of freezing up the water circulating system of the car. The use of oil or gas stoves is not to be recommended in motor houses, as if there is any leakage of petrol, the vapour is likely to become ignited and cause damage to the car and house. Where the motor house occupies a sheltered position, and the temperature hovers about freezing point, a good thick sack or rug may be thrown over the radiator and bonnet: this will prevent a rapid fall of temperature, and in most cases prevent the freezing up of the radiators, although it is not absolutely infallible. As but a small quantity of water is now carried in most types of cars, the simplest and the cheapest way to prevent damage is to have a drain tap fitted to the lowest point in the system and to run off the water before putting away the car.

OVERHAULING A CAR IN A PRIVATE GARAGE.

AMATEUR OVERHAULING. — ABILITY TO UNDERTAKE THE WORK.—SPACE REQUIRED FOR OVERHAULING CAR.—THE NECESSARY TOOLS.—MOVING THE BODY.—NECESSITY FOR SYSTEM IN DISMANTLING CHASSIS.—DISMANTLING THE CLUTCH.—REMOVING THE GEAR BOX.—TYRES, BALL RACES, AND SPRINGS.—DISMANTLING THE BACK AXLE.—MESHING THE BEVELS.—THE ENGINE.—SETTING THE DISTRIBUTION GEAR WHEELS.—ADJUSTING ENGINE BEARINGS.—OVAL CRANK PINS.—GRINDING OR LAPPING-OUT CYLINDERS.—TO TEST ALIGNMENT OF SHAFTS.—AVOID SCAMPING THE WORK.

Amateur Overhauling.

418 The overhauling of a car at a works or garage is an expensive matter, and one of the principal reasons for its costliness lies in the fact that a very considerable portion of the total time spent on the car is actually occupied over work which, while certainly calling for some intelligence, and skill in the use of tools, yet does not demand the technical knowledge of an expert mechanic; such, for example, as the removal of fittings and the body, the taking down, cleaning, reassembling, and adjusting of brake mechanism, wheels, steering connections, valves, water pumps, simple clutches, and the like.

This fact must have led many a private owner to consider the possibility of overhauling his car at home. For the novice with no taste for mechanical pursuits to attempt it would be folly, and in any case an amateur must proceed with caution, undertaking no delicate work he is not beforehand fully assured of his competence to perform. If he decide upon the overhaul, and be uncertain of his ability to cope with those parts of the work that require technical skill and mechanical training, he can probably arrange for the services of a properly qualified mechanic to assist him; or, to put the case more truthfully though less flatteringly, whom he can assist, doing what he is told and no more; and he should be particularly careful, whether working under a mechanic or not, never to take down any parts without so marking them that they can be replaced in exactly their original

positions. This matter of marking parts is an important one in certain departments of the work, and will be dealt with more fully in connection with those departments.

Ability to Undertake the Work.

419 Before an owner can arrive at a definite conclusion with regard to the practicability of a private overhaul, and as to the likelihood of his work being successful, three main questions have to be considered: Firstly, if he have skill enough; secondly, room enough; and, thirdly time enough. The first of these was briefly touched upon above. It is of the most weight, and, unfortunately, too, the one in which I am least able to afford help. Speaking generally, no one should undertake a complete overhaul unless he be thoroughly familiar not only with the broad principles of car mechanism, but also with the details of the car he is to work on; nor ought he to attempt advanced mechanical work (such as scraping brasses) if he has not had shop experience. Addressing for the moment those who have not the advantage of a workshop training, I would urge as a preliminary to the overhaul the perusal of all the books on car work they can come by. Although none would be so foolish as to deny the greater value of a practical training, the intelligent amateur with a sense of his own limitations will find a great deal about workshop practice and methods in books upon this subject—the "Hints and Tips," for instance, "The Autocar Handbook," and "Practical Motor Car Repairing" (Eric Walford), to mention but three of those published by Iliffe and Sons Ltd.

Perhaps this question may be summed up in a few words thus: If a man have enough confidence in himself to start on so big a job, he probably has sufficient skill to carry it through; and if his liking for mechanical matters enables him to face the prospect of spending several weeks in overalls, it may be assumed that he possesses the requisite natural ability to bring his work to a successful termination.

Space Required for Overhauling Car.

420 The second question is more easily answered. At least three times the space the complete car takes up is necessary, and if there be more, so much the better. A good light also is very desirable; plenty of light and plenty of room make for comfort and speed in working; although much may be done under very unfavourable conditions. A bench and a strong vice may be said to be necessities.

The third question, again, presents little difficulty. A garage overhaul for a medium-powered four-cylinder will usually take six to eight weeks; the private owner having the help of his chauffeur or an intelligent lad may estimate the time, roughly, as twice that of a garage overhaul, since he will probably not put in the steady ten hours' day of the garage men, nor will he get so much done as they would in a given time, owing to his unfamiliarity with the work.

The Necessary Tools.

421 The tools required for an overhaul are not many more than are commonly found in the toolkit of a car. Spanners, a large shifting spanner, a couple of small ones, two or three screwdrivers of different sizes, two pairs of pliers, gas pliers or grips, large and small hammers, chisels, two or three punches, a centre-punch, and half a dozen files of various kinds. If the amateur have experience enough to scrape brasses, turn, braze, and forge, he will know, and probably already possess, those tools and appliances necessary for those branches of the work. A breast drill is a convenience, and a soldering outfit desirable. A lathe is extremely useful, of course, though more frequently than not it happens that the turning work in an overhaul is either connected with small parts that can easily be packed and sent away, or with large ones—truing crank pins, for example—that the lathe usually found in a motorist's workshop will not take. Most of the small turning can be done locally, perhaps, and the large work, if there be any, sent to a really big firm.

Moving the Body.

422 Coming now to the actual work of the overhaul, obviously the first things to be done are the removal of small fittings, the wings, running boards, underscreen, and the body. This last, if a light four-seater, may be lifted by two men, but in most cases three are necessary. A body is heavier than some think, and is awkward to handle; moreover, it must not be let down or jarred—particularly if it be a limousine. Probably four, and possibly five, men will be required for lifting off a closed body. It is important that the wheels should be blocked to prevent the chassis rolling, and the body must be lifted off at the back—not over the side. If heavy, rollers may be placed between it and the frame, a very stout packing case being arranged to receive the back of the body when the front begins to tip up. When in this position—the front on the back of the frame and the back on the packing case—the men can get close to it and lift,

which they could not do so advantageously before on account of the back wheels. Stools or stout cases should be in readiness for the body to rest on in the place where it is to be stored. It is best in a separate building, but in any case should be kept away from the dust and grime of the workshop.

Necessity for System in Dismantling Chassis.

423 The body being removed, the chassis may be stripped down to the frame in any order found convenient. The lighter details, such as carburetter, induction pipe, magneto, water pump, oil leads, wiring, etc., should come first, and then the exhaust pipe, silencer, radiator, fan, dash, and steering column. This method will give clear access to engine and transmission. Each part should be carefully laid aside in a safe place as it comes away, and *not* strewn round on the floor. Boxes should be provided for nuts, bolts, and other small loose parts, and as far as possible nuts and bolts should be kept with those parts to which they belong, *e.g.*, fan, fan supports, and bolts all in a box together. This systematic stowage may not always obtain in a works, but it will save the amateur much trouble and loss of time.

Dismantling the Clutch.

424 Next comes the clutch. If it can be removed entire without disturbing engine or gear box, as in most modern cars, so much the better; but if not, it will frequently be necessary to dismantle it before the engine or gear box can be taken out. A careful examination will determine this point, and also, if it must be dismantled, the proper method of doing it. Almost invariably the first step in dismantling a clutch is to render the spring inoperative, by compressing it and tying it up, or by allowing it to expand fully. In the case of cone clutches of the external type the spring may be compressed by the pedal or by a crowbar, and bound up with wire or strong cord. With the internal type, the spring being compressed as before, the clutch ring or female member can be removed and the spring gradually released. Before the clutch ring is freed from the flywheel both should be marked to ensure the holes registering properly when assembling. In the case of any special clutch, such as a multiple disc, flat plate, or internal expanding, a glance at its construction will decide how best to proceed. A word may be added, however, to those who have never had a clutch down: It is, that the spring is a strong one, and should be treated somewhat as a wild beast—with caution and suspicion until it be caged.

Removing the Gear Box.

425 Either engine or gear box follow—both heavy items demanding care. Single and double-cylindered engines can generally be lifted out entire, and this, where practicable, is the proper method; but, if necessary, a four-cylinder may be considerably lightened by taking off the cylinders, and if it be under 30 h.p., will then not be too much for a couple of men to lift. The pistons should be well cushioned with rag or waste, and the connecting rods tied against the sides of the crank case, lest they should fall and the pistons break.

The gear box is usually a straightforward job, but it occurs sometimes that a very large box, if no tackle be available for raising it, has to be dismantled in the frame, and if the lugs to the cross members are on its upper half a little ingenuity is required. A plan I recently tried with one of my own cars was to pump the tyres hard, place packing beneath the gear box, and let air out until the box settled down on the packing. The bolts through the lugs could then be removed, and the top half of the case and the shafts taken out very comfortably. The same processes were gone through in inverse order when assembling, and there was not a hitch at any time. A similar plan might be adopted with a heavy engine.

Engine and gear box can be taken direct to the workshop, but work on them should be deferred until the frame and wheels are finished. The frame is then ready for the reception of each part as it is finished.

Tyres, Ball Races, and Springs.

426 The frame must be slung or packed up for the removal of wheels, springs, and axles. It will, perhaps, be best to begin with the front, and in the case of a heavy frame it might be desirable to assemble the front axle, wheels, and springs on it before dealing with the back. The tyres should be taken off, the rims scraped and painted inside, the wheel bearings well sluiced with paraffin, new ball races fitted if necessary, steering pivot and tie rod pins taken out, cleaned, greased, and replaced, new split pins being used. Ball races should be thoroughly dried after the paraffin—a little petrol will help—and packed full of grease. If the bearings be plain the caps should be filled when they are set up with Stauffer and thick oil mixed to the consistency of cream. The shackle bolts must come out of the springs, and if worn, new ones should be substituted. The leaves of the springs must be taken

apart; the spring is held in the vice while the bolt holding the leaves together is removed, and the vice jaws are then slowly opened. The leaves must be marked—one dot on the outside edge of each leaf of the right-hand spring, two dots on the outside edge of each leaf of the left-hand spring, for instance. This prevents the leaves of the two springs being mixed, and also ensures their not being replaced "end for end." Rust and dirt are cleaned off with emery cloth or a wire brush, and the springs set up with graphite and grease, or Russian tallow and graphite put on warm and liberally. Tallow is good, as it sets hard, keeps out the wet, and does not work out as grease does. It is good also for shackle bolts. The springs will pay for care of this kind, and there is a noticeably greater comfort in the car afterwards.

Dismantling the Back Axle.

427 The back axle is rather a large job, except, of course, in the case of a chain-driven car, when the differential and driving-shafts are in the gear box. With a shaft-driven car the driving-shafts of the wheels usually come out at the ends of the axles, and the axle casing is divided in the middle. As soon as they can be got at, the adjustments of the crown and bevel should be marked, in order that they may be first replaced as they were before being taken down. Final adjustments must be left for actual trial on the road. The details of the construction of the axle should be mastered from a handbook or a maker's list before dismantling it, and the two halves of the axle be taken apart carefully, as the differential and crown wheel are liable to fall out suddenly, with a gush of grease and black oil. It is a good plan to steady the axle upright on one of its ends, and after the bolts holding the two halves together have been removed, the upper half can be lifted off, leaving the differential and crown wheel lying in the lower half. A sharp look-out while doing it should be kept for ball races, thrust washers, or loose balls that may tumble out of the top half of the casing as it is lifted away, and be lost in the flood of thick oil. Every part must be cleaned with paraffin and an old paint brush and dried with rag or waste. When the halves of the casing and the bevel are cleaned and dried the differential may be similarly treated. Examination of the whole of the mechanism of the axle should now be made, worn parts noted, and a decision arrived at as to what new parts, if any, will be necessary. If the materials of the pinions were originally good and of a like hardness, it will be shown by the wear on

the teeth being fairly equal, and any burr on the edges may be reduced by an old file or emery cloth wrapped round a file; but if there be great or unequal wear, replacements will probably be necessary. With respect to the ball races, anyone who knows anything about a bicycle can recognise pitting and heavy wear, and is able to form a moderately safe opinion as to the condition of such parts. If the amateur doubt his own judgment over the pinions, squared or castellated shafts, etc., some mechanical friend with a shop training can generally be found who will help with his advice, which will also have the merit of being disinterested.

Meshing the Bevels.

428 After the necessary work on the axle has been completed it may be set up (new split pins being used) either dry or packed with grease. The latter method is the more usual, and the former facilitates adjustment. There are a few cars in which the meshing of the crown and bevel can be seen after the casing is together through an inspection cover; but in the majority of cases it has to be done by "feel"—one might say by guess, and not be far wide of the mark; and the same might be said of the adjustment of the ball bearings on which the differential box itself runs, when they are adjustable. If they be not, matters are simplified. The depth of the meshing of the teeth of crown and bevel cannot be altered in a scientific way by either lateral or longitudinal adjustment alone. Considered theoretically, the adjustment should be by a combination of the two, so arranged that its direction is at right angles to the cone radius. Practically speaking, however, not much more can be done—unless by the expert factory testers, whose experience has crystallised into a sort of instinct—than adjust tightly and then slacken a little beyond the point where the bevel turned by hand with the wheels jacked up runs freely, with no binding or sticking. A certain amount of backlash will be perceptible in even a new axle.

If the bevels hum unduly on the road a slight modification of this adjustment should be tried, and if they were reasonably quiet before the overhaul they should be set up again as they were. In the works, different bevels are tried with different crowns and varying adjustments until a pair be found that will run quietly, though less of this experimenting is needed now than formerly, as modern gear planing machines will cut bevels with a near approach to accuracy.

The Engine.

429 Before commencing the task of dismantling the engine, it is as well to provide oneself with a complete set of engine joint washers especially for facing the joints in the inlet and exhaust pipes. The original washers are often spoiled in detaching the pipes, and unless a set of new washers be ready to hand unnecessary delay will occur. A joint may be made with asbestos card smeared with graphite, but this substitute possesses certain disadvantages, for unless the two faces of the pipe are perfectly square the asbestos is liable to "blow" and leak badly.

If the cylinders have not already been removed they should be taken off first, and pistons and connecting rods stripped from the crankshaft. In engines nowadays the lower part of the crank chamber is usually detachable without disturbing the main bearings. In this case the removal of the connecting rods is a simple affair. The engine being supported on stools by the lugs of the crank chamber, and the lower part of the latter taken away, the big end caps can easily be got at. If the crank case be halved through the main bearings, however, its lower half must rest on packing and the upper half be lifted gently off, care being taken as it passes, and after it has passed, the pistons that the latter do not fall.

It is important that engine parts liable to misplacement should be marked; and it will generally be found the makers have already done this, but if not, some simple system such as the following may be used: Call the cylinders 1, 2, 3, 4, counting from the front, and mark all parts on the near side of the engine, or in the case of piston and gudgeon, on the front. For No. 1 cylinder, one dot on cylinder flange (near side), gudgeon (front), piston (front), one dot on big end, one dot on upper brass over against it, one dot on cap, one dot on lower brass over against it (all near side). For the parts of No. 2, two dots, and so on. Valves need not be marked, as they can be taken out, ground in, and replaced, each one separately; but connecting rods and parts will all be down at the same time, and so it is necessary they should be marked.

Setting the Distribution Gear Wheels.

430 When the camshafts are taken down, the teeth of the wheels should not be disengaged until they have been examined for the makers' marks showing how they considered the timing should be set. Frequently one tooth of one wheel is marked and two adjacent teeth of the other; the intention obviously is that the marked tooth of the former

should mesh between the marked teeth of the latter. Before the wheels are taken apart they should be turned until the marked teeth are brought into coincidence. It may occasionally happen that they do not coincide; in which case, if the engine has been giving satisfaction, the inference is that someone has improved the original setting, and they should be marked and set up as they were found. If, on the other hand, the engine has run badly, the original setting should be tried when being reassembled.

Adjusting Engine Bearings.

431 Every part of the crank case should be well cleaned with paraffin, paraffin forced through any oil leads or passages cast in it; gauzes, filters, and oil pump cleaned and dried; and then an examination made for wear. Begin with the main bearings. Set up the crankshaft in them, and see if there be any side shake—a very small amount of end play is not really objectionable. If there be much shake it must be attended to, and if the brasses be lined with white metal they may need relining, for which work a blowpipe and lathe are necessary. If the crankshaft be on ball bearings, new races may be required. Brasses are "taken up" by filing the halves so that they come closer together, and then scraping the inside till the shaft takes a good bearing all round. As the brass is then smaller than the bed it rests in, a piece of very thin foil or other packing is placed in the bed and cap in order that the brass may be gripped firmly. In the case of a big end, the rod and cap, as well as the brass are usually filed; packing is not good practice here, as it is liable to shift and be battered to pieces under the continual hammering of the explosions.

Put thus, in non-technical language, taking up a brass sounds a rather simple matter, but in practice it demands considerable skill and experience. The amateur will probably find it advisable to call in the services of a trained mechanic for this work, but if he do it himself he should read all he can find on this subject, and not be discouraged when he finds his brasses apparently getting worse instead of better towards the close of the scraping, for there is frequently a short period when appearances are very misleading.

Oval Crank Pins.

432 When the main bearings have had attention the connecting rods should be set up, one by one, on their respective crank pins. These latter tend to wear oval

and so do the brasses, and they, consequently, are more trouble to take up than the main bearing brasses are. If the crank pins are only very slightly worn they may be dealt with by the *judicious* use of a smooth file and emery cloth. But the proper method, especially if there be much wear, is to have them ground in a special crankshaft grinding machine by some large firm making a feature of the work. Not one garage in fifty possesses such a tool; if there be a grinder at all it is neither large enough nor heavy enough to take a crankshaft of more than very moderate dimensions, and there are difficulties in chucking for the crank pins. The lathe presents the same chucking difficulties, and is a poor substitute for the grinder. If the crankshaft be sent away to have the pins ground it will be advisable to send the connecting rods and brasses also, in order that the latter may be relined or renewed if necessary, and properly fitted to their pins by the firm's experts. If the big end brasses can be satisfactorily taken up, a rather considerable amount of end play—for which there is no remedy short of renewing, or possibly relining—need cause no great anxiety, unless the car is to have a great deal of heavy work, with no prospect of another overhaul for some time to come.

Gudgeon pins and bushes should next be examined, and renewed if much worn, as nothing in the way of taking up can be done, of course. After these come the cams and tappets. What attention they will require beyond a thorough cleaning will depend upon circumstances. If the cams are pinned or keyed to the shaft a new one could easily be fitted; in the case of a camshaft machined from the solid a whole new shaft would be necessary if any one cam were badly worn.

Grinding or Lapping-out Cylinders.

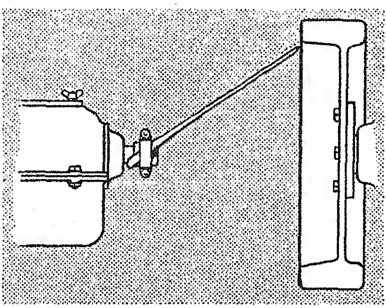
433 If the cylinder be appreciably worn—*i.e.*, if a slight ridge or shoulder can be felt at the lowest point of the rings' travel—they need grinding. New rings can be put on, but as their slots must be filed sufficiently to permit their passage past the unworn part, there will be too large a gap when the worn part is reached. If, however, the engine has satisfactory compression and there are no signs of rubbing on the piston, the old rings may be put on again for a time, particularly if the owner is doing only such work as is absolutely necessary.

The engine is usually the biggest and longest job in the overhaul, and after it the gear box will present little difficulty. Bearings and the condition of pinions are the chief things to

consider. Ball races can be renewed, brasses taken up, and a badly worn pinion can sometimes be trimmed up, case-hardened again, and its life thereby lengthened.

To Test Alignment of Shafts.

434 When the engine and gear box are set up in the frame care must be taken that the axes of the crank-shaft and mainshaft of the gear box are in line. This may easily be tested by affixing to the mainshaft a pointer of stout wire so that its end just clears the flywheel periphery. It will probably be found when the shaft and flywheel are turned that the pointer will touch in some places and run wide in others, and things must be so arranged—by packing under the lugs or otherwise—that the pointer and flywheel run true with each other. (See sketch.)



Only small details are left now, and though many of them are important, the work upon them is mostly of a comparatively simple nature. The steering box must be attended to and adjusted; it may be that when adjusted correctly for extreme lock it will be loose midway. This can be improved by adjusting the teeth deeper and scraping those at the ends of the segment to suit the worm. The ball joints must come down, be closely examined, thoroughly cleaned, and very carefully put up. If there be any doubt as to the condition of any part of the steering mechanism some person of experience should be consulted. The same remark applies to brake-work; new shoes or linings should be fitted, and every joint and pin carefully gone over when they are set up—they should not be passed as correct until each part has been examined. Omitting to open a split pin in some rather inaccessible corner may mean a brake failure at a critical moment.

Avoid Scamping the Work.

435 Even now a host of little items are left, such as magneto, carburetter, cleaning the cooling system, grinding valves, etc., but these, and such as these, although coming within the work of the overhaul, are matters with which the amateur may be presumed to be familiar, so that mere passing mention of them will suffice. All must have attention, and no work, particularly upon the engine and transmission, should be hurried or scamped. The golden rule, too, throughout the overhaul is to hear the counsel of all and act upon one's own judgment. Mistakes may, and probably will, be made, and the mechanics of the neighbourhood may, and probably will, mock in secret at the bunglings of the poor amateur. He, however, will be well able to comfort himself in the knowledge that he is gaining much valuable experience by his intimacy with the construction of the many details of his car, and saving much good money at one and the same time.—G. M.

ON TUNING UP A CAR.

Searching for Efficiency.—Test of Individual Adjustments Advisable.—Carburetter Adjustments.—The Timing of the Magneto.—Valve Opening.—Gear Ratio.—Larger Wheels or Tyres.

Searching for Efficiency.

436 It is in no light or frivolous spirit that I approach this subject. There is a veil of mystery hanging over the solemn rite of tuning up, to disturb which would, I feel, be both sacrilegious and unprofessional. I should be very sorry if any rash words of mine should be the innocent cause of a broken crankshaft to an otherwise blameless and well-conducted automobile, and such accidents dò occur after ill-timed attempts at tuning up. Still, our sane man for whose benefit these hints are written if he be only half as sensible as I imagine, is certain to desire the maximum of efficiency from his engine, while at the same time he is far too fond of his car not to exercise commonsense in the process of tuning up.

The following notes are the result of my own experiences in the search after efficiency. They refer primarily to preparing a car on the racing track—the finest school in the world, whatever a weak-kneed section of the press and the public may say to the contrary, in which to gain experience. But they are intended just as much for the genuine amateur mechanic who wishes to improve his average from the lodge gates to the post office, and provided he will exercise reasonable care, there is nothing in them that he will not be able to accomplish with satisfaction to himself and benefit to his car.

Test of Individual Adjustments Advisable.

437 Seeing that a trait of motoring is, and always has been, that spirit of happy-go-lucky carelessness which affects alike the high-class manufacturer who sends out a new chassis without oil in the gear box and the private owner who sets off for a long tour with one previously punctured inner tube, it is important to insist on a regular sequence of events in the tuning-up operations. Otherwise it may be difficult to know which particular adjustment accounted for a marked improvement or the reverse, and for this reason it is desirable never to make two changes at the same time, and always to verify each result, with the help of a speedometer.

Assuming that there are no serious defects to contend with, such as loose bearings or cracked cylinders, the first thing to be attended to is the compression of the engine. This is one of the few occasions on which the engine gives you all the help in its power, and it is unnecessary for me to point out that when a particular cylinder hisses like a basket of snakes the application of a little soap and water or oil to the exterior joints will infallibly reveal the leak. Grinding in valves or low tension tappets, renewing and equalising the washers on valve caps and sparking plugs, ensuring that the piston rings have not slipped into a position where all the slots are in line with each other, are equally matters of common knowledge and practice. The timing of inlet and exhaust valves also affects the compression, but of this more later on. Assuming that the cylinders either are or have been made compression-tight, the only other point to be considered is whether or not the engine can safely be run with a higher compression than that for which it was designed, *i.e.*, whether it is desirable to reduce the space in the combustion chamber. This can be done in several ways. For instance, by screwing a plate on to the top of the piston; by removing the metal washer which is inserted in many engines between the cylinders and the crank case, and so lowering the cylinders a few millimetres on to the base chamber without affecting the positions of the pistons; or by fitting valve caps which shall enter the pocket further, if the lift of the valves allow of this. It is true that nearly all phenomenal speeds have been accomplished by cars running under very high compression, but there is always the danger of a broken half-time wheel or connecting rod, due to preignition, to be reckoned with, and so far as ordinary running is concerned, it is doubtful whether the increased efficiency of the engine makes up for the loss of flexibility and regular firing at low speeds. As a general rule, it is not desirable to increase the compression to any point over 80 lbs. to the square inch.

Carburetter Adjustments.

438 The next matter to consider is the carburetter, and it is no exaggeration to say that in successful "monkeying with the brass pot" (as a disgusted passenger once described my delicate roadside adjustments) lies more than half the secret of obtaining good results from all cars of all ages and types for whatever purpose they may be required. To start with, it is unfortunately a fact that makers by no means always send out their cars fitted with a type of car-

buretter that suits them best, and I could quote half a dozen cases where fitting a new carburetter has apparently made all the difference between a good car and a bad one. But given that the type is reasonably satisfactory, there are two very important adjustments to be carried out which may mean a difference of anything from one to ten miles an hour in speed, or perhaps a halving of the petrol consumption. The first has to do with altering the jet, and the second is in the matter of varying the supply of air. With regard to the jet, my advice is obtain a spare one, or even two or three, with which to carry out experiments. It is easier to make extra holes, or to enlarge those existing, than it is to fill them up again satisfactorily. Beyond that it is merely a matter of "trial and error," and the possible experiments are neither difficult nor dangerous.

Neither is there much necromancy about air adjustments, though I do not know of anything that gives more astonishing results for a minimum of trouble. Some time ago we were tuning up a big car that I was to drive in a race at Brooklands, a car that should have been capable of averaging 80 to 85 m.p.h., but for a very long time 62 m.p.h. was the highest speed we could get. Then when we had sent a disconsolate telegram to its owner suggesting that it might not be worth while entering for the race at all, we discovered the advisability of giving the carburetter a still larger proportion of air. The effect was instantaneous; the engine seemed to take hold with both hands, so to speak, and for the first time to take an interest in the proceedings. The first round was five miles an hour faster—a big improvement at those speeds where each extra mile per hour means a considerable increase of horse-power. Then a further adjustment, and a round at 69 m.p.h. Then a long and wearisome delay, with no improvements, but rather the reverse, till, with a bound, after one desperate adjustment, we managed 72 m.p.h. in the teeth of a gale. And so on, and so on, till at last we were able to telegraph "78 m.p.h." to the owner, and to sit down and prepare schemes for increasing the gear ratio. The foregoing is one experience out of a score that could be quoted, but it should be sufficient to show that it is worth while to take a little trouble over this particular adjustment.

Unfortunately the correct carburetter setting at 4 p.m. on Tuesday is by no means right for mid-day on Wednesday, and I well remember one race where hours of patient labour (the carburetter was clumsily designed, and each alteration involved about twenty minutes' work) on previous days, which had been warm and sunny, were made useless by the

fact that the race itself was run in a snowstorm! Before leaving this branch of the car tuner's art, it is worth mentioning that remarkable results are said to be obtained by employing what we may call "forced draught" for supplying air to the carburetter; in other words, by fixing a funnel to the air inlet shaped like a megaphone, with the big end opening towards the radiator, and, in addition, in some cases, by employing a fan inside this funnel. A scheme I once tried myself on a racing car—fixing extra air valves of an automatic pattern into the valve caps on each cylinder and bringing them into action as soon as the engine was running its fastest—was anything but a success.

The Timing of the Magneto.

439 Next after the carburetter comes the magneto. There is less to be done here, but that little requires much care, and there are risks of damage in the event of a mistake. Still, there is no doubt that correct timing is second only to correct carburetter adjustment in obtaining the best results from a car, and with care there is no reason why anyone should not be able to advance or retard the magneto by one or two teeth, which is all that is likely to be necessary. I am assuming, of course, that the contacts and connections are clean and efficient, for the man who is unable to guarantee this is not, to my way of thinking, fit to take a car five miles from the nearest garage. The only advice I have to offer to the investigator of magnetos is, before setting out into the region of armatures, brushes, and distributers, be certain that available literature on the subject has been mastered, and an acquaintance formed with the geography of the country about to be explored. Nowadays so many excellent handbooks have been published describing in detail all the ignition systems in common, or uncommon, use that the discovery of the "maximum position," etc., should present no difficulty.

A very slight alteration will generally have quite a considerable effect. I have known cases where advancing the magneto one tooth increased the speed of the car by five miles an hour, and yet one tooth more produced a knock which must have imperilled every connecting rod and bearing in the engine. Here, then, as in everything else connected with the internal combustion engine, avoid excessive alteration at one adjustment.

Valve Opening.

440 Whilst on the subject of the timing of the magneto, it is worth while to consider whether any advantages

are likely to be gained by experimenting with the timing of the inlet and exhaust valves. The rough idea is, as nearly every motorist knows, that the exhaust valve should begin to open just before the end of the firing stroke, and the inlet valve at the beginning of the suction stroke, but practically every engine has its own individual variation of the general rule. In the majority of cases the most effective setting has presumably been ascertained before the chassis left the works, but as there is no particular danger in slightly altering the timing of the valves, there is no reason against, at any rate, verifying this setting, keeping in mind that the two objects in view are to get the largest possible charge of explosive mixture into the cylinder, and to ensure the most complete expulsion of the burnt gases. I remember one case where a bad loss of compression was found to be due to the inlet valve staying open too long, involving an alteration of the timing. The fact that any alteration in the relative position of the half-time wheels means taking down the radiator and removing the front of the crank case is to a certain extent a guarantee against light-hearted meddling.

Gear Ratio.

441 When the compression of an engine is such that considerable strength is necessary to turn the starting handle, when the carburetter has been adjusted to a nicety, and the timing of the magneto and the valves satisfactorily accomplished, it may be taken that the engine is developing the maximum power of which it is capable, and the next matter is, maybe, to see whether an alteration of gear will make the car go any faster. If it will only just take top gear, it is obviously waste of money to buy larger sprockets or bevels, but it is quite possible that the increased engine efficiency is sufficient to cope with a slightly higher gear, and it is remarkable that many cars which have previously seemed deficient of life and energy can sometimes be improved out of all recognition even by the simple expedient of fitting larger tyres. After all, since no two cars are required for exactly the same purpose, it is rather ridiculous to insist on the same gear ratio in every case, and a good deal of the mystery overhanging the high speeds attained by racing cars is due to the variation of gear ratios. This is, however, in the nature of a digression; all that we are concerned with is the fact that, having worked the engine up to the highest pitch of efficiency, we may be able to obtain still better results by altering the gear.

Larger Wheels or Tyres.

442 With a chain-driven car it is simple enough to change the sprockets; altering the bevels on a live axle car is rather a more serious job, as there is a considerable amount of labour involved in taking down the back axle of such a car, and there is always the possibility that the new bevel may prove to be slightly too big for the casing. The fitting of larger driving wheels or tyres is a simple way out of the difficulty, though it must be remembered that this also increases the weight. If the rims be suitable, fitting a larger sized tyre will sometimes be a decided advantage. But whatever means are adopted, it is worth while taking some trouble to ensure that the car has a suitable gear for the work it is called upon to perform, whether at Brooklands or in the Highlands of Scotland, always bearing in mind that it is unreasonable to expect identical performances, as far as speed is concerned, in both places with the same car.—S. Gore-Brown.

HOW TO LAY UP A CAR FOR THE WINTER.

MOTORING ALL THE YEAR ROUND.—VENTILATION OF GARAGE.—CARE OF TYRES.

Motoring all the Year Round.

443 We have received several enquiries from readers who purpose laying up their cars during the winter months, and our correspondents seek information which is embodied in the following query: "What shall I do to my car, before laying it up for the winter, to preserve the various parts in good order and to ensure its being in good condition when I have use for it again in the spring?"

Before replying to the query, we must in the first place protest against the idea of there being any necessity to abstain from using a modern car in the winter months, for there is no more reason why it should be put out of use because of a few degrees lower temperature or a slightly increased rainfall than there is in the case of a horsed carriage. There are without doubt many days and week-ends during the period between autumn and spring when the atmospheric conditions will allow even the most "tender" of us safely to enjoy the pleasures of a forty or fifty miles run. In our experience, some of the most enjoyable and exhilarating drives of the whole year have been on occasions when we have taken advantage of some of those bright crisp winter mornings.

However, we do not imagine that in a few words, such as space allows, we shall be able to induce all our correspondents, and others who are with them on this matter, to give up the idea of definitely putting their cars away until the spring time, so we accede to their request for advice and information as to "what to do."

Ventilation of Garage.

444 A first essential is that the building where the car is to be stored shall be reasonably free from dampness and well ventilated. A building hermetically sealed, heated or unheated, is not desirable. Dampness is certain to exude from the ground and walls, especially after the colder spells and in the early spring. A well-ventilated building will compensate to a great extent the certain

amount of dampness which must accrue in any event during the winter, but the circulation of air will disperse this on the brighter and drier days. If heating apparatus is in position in the garage so much the better, but it is not by any means essential to the well-being of the car if reasonable precautions in the matter of ventilation be taken. To counteract floor dampness, a thick sprinkling, say half an inch to an inch in depth, of dry sawdust may with advantagebe put on the floor before finally leaving the car, but not until all the other matters referred to herein have been attended to.

The weight of the car should be taken off the tyres and wheels by means of jacks or wooden blocks supporting the front and back axles. Where detachable rims or wheels are used, it will be advisable to remove these and put a thin coating of grease on the metal parts liable to become rusted by disuse.

Care of Tyres.

445 The matter of tyres—the removing of them or otherwise—is quite optional, and although perhaps, if the time is available, it would be an advantage to remove them and clean the rims—storing the covers and tubes in a dry, dark place—it is not essential for their well-being if air pressure, slightly below the normal, is retained and attended to periodically during the winter.

Petrol and oil should be drawn off into cans and the water run out of the engine, radiator, etc. Most careful attention should be paid to this latter; no trouble should be spared to make sure that *all* the water is cleared from cylinders, radiator, water pump, pipes, etc., and the drain taps and plugs should be left open and detached respectively.

It is not advised that the cylinders should be washed out with paraffin until just prior to re-use in the springtime, but by copious doses of lubricating oil ensure that cylinder walls and pistons are well coated with oil. Drain out the base chamber, leaving the taps open, or the plugs out, so that sediment may gradually find exit.

As regards accumulators, it is better to discharge and recharge them, say once a month (discharging to 3.8 volts or so by means of a small lamp), whilst not in use, rather than the alternative, *i.e.*, draining out the acid and swilling out with clean water, for they are then available immediately they are required in the spring, and the otherwise necessarily careful recharging is avoided. The magneto should be left in position, untouched, but the clutch, if of leather cone type, should be well dressed with castor oil and retained from contact with the

flywheel by securing the clutch pedal with wooden block or rope. If time be available and a great deal of trouble be not involved, a better plan than securing the clutch pedal in a position held "out" against the pressure of the spring is to release the latter altogether by slacking back the adjusting nuts.

The upholstery, if leather or imitation, may with advantage be treated with a small quantity of leather dressing well rubbed in, and, of course, all bright steel parts should be greased. A coating of Rangoon oil on brass and copper parts will preserve them and avoid serious tarnishing. The bulb of the horn may well be removed and taken into the house and kept in a living room, in a position neither very hot nor the reverse, but preferably dark, to preserve the rubber.

We have refrained from recounting other than the barest necessities for storing a car; such a matter as advice on overhauling during the period of storage does not come within the scope of these present suggestions. But if the advice we have given be followed out in the various details, there is no reason why any part should suffer during disuse, and, moreover, the car will be ready for use in a very short time when a decision is made to take it into use again in the spring—or earlier, if our advice on winter driving be eventually followed.

MISCELLANEOUS.

Overloading Chassis.—The Necessity for Care in Storing Grease.—Preparing a Car for an Election.—Rope.—Utilising Heat from the Engine.—Taps Shaking On and Off.—Jacking up Low Axles.—The Use of the Soldering Bit.—Taking Control Wires round Corners.—Cleaning Aluminium.—To Stop Box Lids Rattling.—Other Rattling Noises.—Back Axle Tension Rods.—Tar Paving.—Lights without Matches.—Fitting or Removing Studs.—Removing Broken Studs.—Removing a Broken Tap.—Removing Stubborn Nut by Heating Spanner.—Tighten up Nuts Carefully.—To Tighten Awkwardly Placed Screws.—To Straighten a Split Pin.—To Prevent a Bolt Turning.—Nuts Loosening on New Cars.—The Use of Spring Washers.—Asbestos Washers.—Weighing a Car.—Keeping the Starting Handle Clean.—How not to Store Goggles.—A Shock Absorber.—Maintaining a Head of Petrol on Hills.—Klaxon Horn Adjustment.—Cleaning Klaxon Horn Commutator.—Soldering Cast Iron.—Tapping Stud Holes.—A Simple Number Plate.—Route Markings.—When Buying a Jack.—Lighting Paraffin Lamps.—Repairing Cracked Water Jackets.—Worn Throttles.—A Rug Tip.—To Remove Water from Petrol Tanks.—Wind Deflectors to Doors.—A Mudguard Improvement.—Case-hardenings.—Refilling Oil Tanks, etc.—Tyre Pressures in Hot Weather. — Hooter Troubles and Repairs.—How to Serve an Oil Drum.

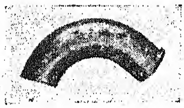
Overloading Chassis.

446 "Page" has a word of warning to utter about several cases of gross overloading which he has come across. He points out that some owners buy a light four or five-seated car, and, after a time, replace the original body by a heavy landaulet or other form of closed body. Then they wonder why the car becomes extremely noisy and slow, quite forgetting that for the extra load such a type of body causes practically nothing in the chassis to be suitable. First of all the frame is probably too weak. That, of course, means undue

distortion, so that the working parts of the car are set out of line. Then the gear ratio is almost certain to be too high, and last, but not least, the springs quite unsuitable. In nine cases out of ten both chassis maker and coachbuilder are blamed for what is really the fault of the owner. We do not say that no chassis first fitted with an open body should be fitted with a closed body, but we certainly do not hesitate to assert that if it is possible to do this satisfactorily it is very certain that the chassis was entirely unsuitable for the open body which it previously carried.

The Necessity for Care in Storing Grease.

447 The little illustration we give shows the actual size of a portion of a steel eye which one of the most careful motorists we know found in his gear box, luckily before it had done any damage worth mentioning. It seems that some time ago he was fitting a little arrangement upon his running board to hold an acetylene generator. He had a steel screw eye which he wished to make into a hook, and so cut a piece off the eye with a hack saw. In doing the job the piece cut from the eye flew off and he absolutely failed to find it. It evidently fell into an open tin of gear grease, and as the grease was thin it disappeared into it. From this tin the gear box was replenished, and with the grease went the small piece of steel. We have often noticed how grease tins are left open. This in itself is a mistake, as a considerable amount of dust and grit must get into the tins, but in a motor house, where all sorts of little things such as nuts, split pins, and so on, may be dropped and lost, it is evident that the moral is to keep the tins tightly closed. Some grease tins are so made that it is difficult to keep them closed, and the remedy is then to have a grease bin.



Preparing a Car for an Election.

448 Since the last General Election several thousands of new motorists have joined the ranks of motor car owners, and it may be well to make it clear to them, if they have determined to lend their cars to assist in conveying voters to the poll, that this work is very rough on the car. It is worse in town than in country districts. In fact, in many of the country constituencies if the owner drives the car himself it will not be much knocked about, but in others it will be damaged more or less, and in towns it will really have to put up with a great deal. The best way to prepare a good car for

the election is to take off the body and replace it by an old one which cannot be hurt. With this old body and a set of improvised wings the car will not suffer much, unless some absent-minded elector mistakes one of the tyres for a razor strop. However, if no old body is available, the wisest plan is to remove all superfluities from the car. If there be a hood it should be taken off and left at home; otherwise it will be used as a gymnasium, and broken. The upholstery should be covered. It is a very good plan to have cushion covers and back covers made for the upholstery, as it saves a car tremendously, and anyone who is contemplating this might just as well have it done now as not. The cost is anything between £3 10s. and £7 or £8, according to the size of the car and material used, and it saves a lot of anxiety in ordinary use, not to mention when used for election purposes. If covers are not fitted it is well to improvise some for the day. The mats should be replaced by sacking, and, unless the car is going to be used after dark, the lamps should be removed, as children always play with these, and grown-up " children " have been known to remove the back lamp as a souvenir of the election. The running boards should be wrapped in sacking, and then, if these precautions be taken, the only part of the car which is likely to suffer severely is the paint. Of course, we are assuming that the owner or his man will not permit people to ride on the bonnet, wings, and steps. If this sort of thing is allowed, of course, there is nothing to be said except that it is a pity the car should not be owned by someone who knows better than to permit it to be abused in this way. Do not allow election agents to pin or nail cards on the centre of the back panel. See that due consideration is given to the fixing of these things in such places and in such manner as to cause no damage to the car.

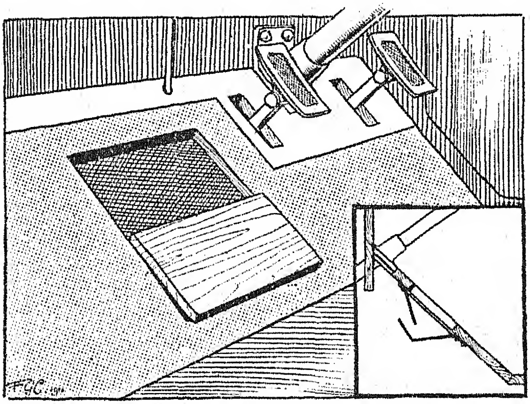
Rope.

449 A length of rope is always handy. The driver may want it himself. Others in trouble may ask him for a tow. In case of all the spare tyres being used up, it may be wound round the rim, and often it will secure the necessary adhesion if wound round the cover on ice-covered roads.

Utilising Heat from the Engine.

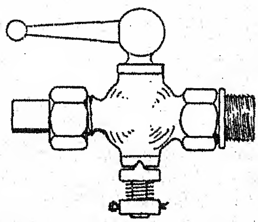
450 The sketch and diagram herewith illustrate a method of using the hot air from the engine as a means of obtaining warmth for the occupants of the front seat of a car. As shown in the sketch, a hole is cut through the sloping floorboard, the slab of wood removed forming a

hinged trap door, the hole being filled in with close wire netting or gauze. Underneath the floorboard two baffle plates are fixed, the object of which is to prevent oil from throwing up directly from the flywheel and passing through the hole in the footboard, and also to prevent the air from the engine carrying a direct mist of oil with it. It is apparent that to pass through the hole in the floor the air first impinges upon



the upper baffle, where any oil will gather and drip on to the lower baffle plate. The latter should be drilled at its lowest point with three small holes to allow the oil to run back into the engine tray. The hinged flap allows of the heat being shut off when not required.

Taps Shaking On and Off.



451 If an owner be troubled with this dangerous practice, unless he is a good amateur mechanic the best plan is to replace all the cocks on the car that by shaking *on* could either let the petrol run out or the water. Many excellent cylinders have been ruined through a cock opening and letting the water out while running. Taps are now obtainable that cannot get to the wrong position through vibration. This is done by cutting in the cock at the small end of the tapered hole a V notch or cam, then providing a

washer that is pushed up by the usual spring to snap into this notch when the cock is in the running position. The stem of the tap upon which the cam piece slides is, of course, square. *Inter alia*, all ordinary plug taps are bad for petrol any way. Petrol should be shut off with a packed screw-down valve—like Messrs. Rotherham's No. 19, for instance.—C. R. GARRARD.

Jacking up Low Axles.

452 The front axles of some of the very low semi-racing chassis now manufactured come so near the ground that it is difficult or impossible to procure a jack which can be inserted under the axle, when a front tyre calls for repair. Up to date I have not discovered a jack stumpy enough in its closed position to pass under the front axle of my own car; and there is no convenient portion of the front chassis by which a front wheel can be jacked up off the ground safely. When I first discovered this, I was afflicted by a burst front tyre, and the exchange of the detachable wheel was effected with some danger to the chassis. The jack had to be screwed up against a front spring, and though it took a purchase on several leaves of the spring, any awkwardness in changing the wheel would have tipped the spring off the jack, and let the car down on one end of the axle. Consequently on reaching home I got the local carpenter to shape a wooden pyramid, with a semi-cylindrical depression across its apex, the height of the pyramid being just sufficient to lift a front wheel clear of the ground with its tyre fully inflated. When a front wheel has to be changed I now raise the car by jacking up the front spring, place the wooden pyramid under the front axle, and lower the car on to the wood block before touching the wheel.—ANON.

The Use of the Soldering Bit.

453 In view of the number of joints about the engine of a motor car, the radiator and petrol tank, that depend on soft solder for their union, it is advisable for every motorist to acquire knowledge of how properly to re-unite them, as well as to include the necessary details in his outfit as a precaution against being stranded miles from anywhere. It is imperative that the surfaces to be united should be thoroughly clean and bright, devoid of dirt, grease, and scale, and the true surface of the metal exposed to the action of the flux. Secondly, unless the nose of the bit is thoroughly clean and well tinned, it is impossible to get solder to run properly and unite, however clean the surface of the work may be.

Preparing the Tools.

The reason why soldering bits are often discovered in a lamentable and useless condition is owing to the want of a little care in heating up, and the absence of the necessary accessories which would ensure the bit, while in use, being maintained in perfect working condition, despite its size or the number of times it may be found necessary to reheat it. Directly the temperature of the bit is allowed to approach red heat, the tin is burned off its nose, and the copper scales and carbonises; it is therefore essential that, while maintaining a high degree of heat to enable the best results to be arrived at, the temperature must not be carried to such a degree as to necessitate frequent refiling and retinning.

The first point to aim at towards becoming a competent manipulator of the soldering bit is to put the latter in order. There are two methods that can be employed—one by contact with a sal-ammoniac block and the other by dipping. Personally, I prefer the former as being by far and away the best and most efficient, not only in the preliminary tinning of the nose of the bit, but in maintaining it in good working order. The latter can, of course, be done equally well by dipping, but it means either that the nose of the bit has to be dipped each time it is removed from the fire into the soldering flux, and thus quickly convert it into mud; or, as an alternative, reserving a separate receptacle containing sal-ammoniac in solution; this does not answer nearly so well as the block, and is always liable to being spilled and to evaporation. Therefore, procure a fair-sized block of sal-ammoniac, and embed it partially in a block of wood as a rigid base and to protect it from breakage; then scoop a shallow hole in the centre, which latter is to contain a globule of solder. Now heat the soldering bit to a dull red heat, quickly grip it in a vice, and file up all four faces of the nose, and slightly round the corners and point (any old file will answer for the purpose), and then insert it in the hole in the sal-ammoniac block, giving it a few twists, simultaneously feeding a little solder against the nose, which will result in the copper bit being cleansed or fluxed and tinned at the same time. If the bit has previously had all the scale removed by filing, the nose will be well tinned close up to the shoulder, and, with proper care, the application of its nose to the sal ammoniac and solder each time it is removed from the fire will clean and keep it in working order.

With regard to the flux, this, for ordinary work, consists of what is generally termed spirits of salts, but more correctly is hydrochloric acid killed by or saturated with zinc, after which

it is usually termed killed spirit. To kill it for after use, a stone jam pot is the best type of receptacle in which both to kill it and to use it, especially when using it also as a dip for the copper bit. The pot should be about one-third full of acid, carried out into the open, and sufficient strips of zinc added to kill and take the fire out of the acid. The acid always boils and gives off noxious fumes and vapour, with the natural result that if the acid is killed inside the workshop any tools or machinery will be rusted by it. All work to be soldered must be thoroughly cleaned or scraped, a little of the flux applied, and a hot bit used to melt and run the solder, remembering all the time that a thin neat joint is stronger and more workmanlike than a thick, clumsy deposit.

Of course, in electrical work, especially when soldering wired joints, resin must be substituted for the acid flux, otherwise chemical action will be set up, and the wires and their insulation destroyed very quickly. In soldering zinc the unkilled acid is the correct flux to use, and it is well, in all cases where acid flux is employed, to wash well or wipe the parts after soldering.

It is said that cast iron cannot be soldered. Quite a mistake. Cast iron can be soldered as easily as any other metal, provided the breakage or joint is filed down to a true surface, cleaned, and made slightly hot.

We now come to another aspect of soft soldering, termed "sweating." This is performed partly with or entirely without the aid of the copper bit—in the former case, chiefly in coating the joint surfaces of bearing brasses as a preliminary to securing them together, preparatory to boring and turning them, the whole when evenly coated being made sufficiently hot to melt the solder, so that, when the two halves are closed together in a vice or under weights, the surplus solder will be squeezed out and the two parts unite. It must be borne in mind that the closer the joint, the stronger will be the resistance to their breaking apart in the process of machining.

Soldering Union Joints.

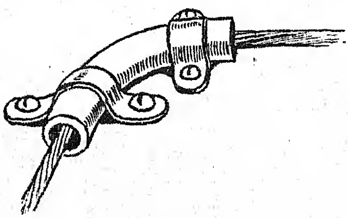
The process of simple sweating applies mainly to pipe joints, such as the union connections of petrol and oil pipes. There are some thousands of such joints made daily, and it would surprise a vast majority of the makers if they were informed that they were anything but sound joints. Properly to unite a pipe and union, the end of the tube must be a good fit in the union, well cleaned and tinned, which may be done by holding the pipe in a blue gas flame (or spirit flame), dipping the solder in the acid, and applying it to the tube,

and when evenly coated just wiping it round with a clean rag. If the union is clean, it will only be necessary to dip the cold tube in the killed acid and insert it in the union, having first warmed the latter sufficiently to enable the surplus solder to give way. The whole is then heated up to a heat sufficiently high to melt a little solder off the end of the stick, and by the continuous application in minute proportion of both acid and solder, and continuous heat, the solder can easily be induced to run through and make a perfectly full and sound joint, which nothing short of heat will dislodge. A few minutes spent in experimenting will readily demonstrate the efficiency of the joint made in the way directed.—H.C.B.

There is one point in the above hint and tip which I have found to be of considerable importance in practice, and which "H.C.B." only refers to incidentally. To obtain a really sound union by soldering the parts of the articles in the neighbourhood of the joint should be raised to a good heat; in fact, the temperature should be about that necessary to melt the solder. At the same time, one must be very careful to avoid "scaling" the surfaces.—D.L.

Taking Control Wires round Corners.

454 The popularity of cut-outs and exhaust horns has resulted in long wires running over pulleys round corners figuring on most chassis, and a certain amount of trouble is experienced with these details. The pulleys are generally carried on cast brackets, which often snap at the waist, where the steel screw enters a brass boss; when they do not snap, they often twist under the pull of the wire, or the wire slips off the pulley and jams between flange and bracket. A much more satisfactory method of taking these wires round corners consists of running them through short lengths of metal tubing, bent to gentle curves of suitable contour, as shown in the sketch.



Copper pipe is easily handled by amateurs—it may be cut with a hack saw, and bent when hot after filling with sand. The bent piece of tubing may be attached to any convenient part of the chassis with staples, but the writer prefers the use of screws, which resist a pull better than sprig staples. He attaches the pipe bends by two ordinary wood

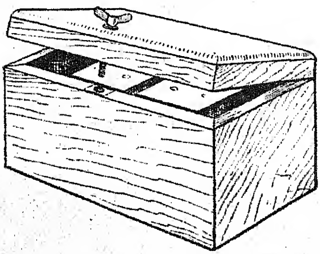
screws threaded through the side plate of a cycle chain link. The copper pipe may be stuffed with grease, when it will afford a silent substitute for a pulley. Needless to say, this advice only refers to wires which are out of sight; the suggested fitting is not neat enough for a visible wire.

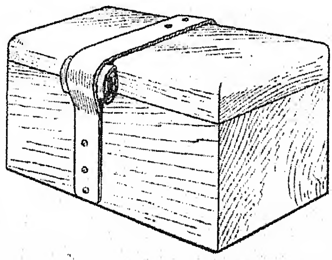
Cleaning Aluminium.

455 The following tip for cleaning aluminium crank cases, etc., may be of interest. I have found that by using a rag soaked in turpentine, grease and dirt are quickly removed and a lacquered appearance given to the surface of the aluminium. It also seems that dirt and grease will not adhere so readily to the aluminium after it has been so cleaned as compared with its propensity in that direction when petrol or paraffin has been used.—R.C.C.

To Stop Box Lids Rattling.

456 The only really satisfactory way with which we are acquainted of stopping the lids of step boxes in which accumulators, lamp generators, or tools are carried from rattling





is to fit screw fastenings. For each lid a couple of thumb-screws should be used. These screws pass right through the lid and screw into brass screw sockets which are let into the sides of the boxes, as indicated in our drawing. Straps and hook fastenings, and even locks, are rarely satisfactory for long, and it is astonishing what an annoying rattle a couple of step boxes with loose lids can make. A good rough and ready way to reduce, if not entirely stop, rattling with strap-held lids is to take a strong piece of rubber tube, such as is used for the water circulation, and put it under the strap, as indicated by the sketch, or a piece of old air tube three or four inches long and about the same width as the strap may be rolled up and put between the strap and the box. It can be tied to the strap with a piece of string to prevent it slipping out of its

place or being lost when the strap is undone, and it will last for a long time. After a while, however, the rubber loses its life, and does not offer sufficient resistance or spring to keep the strap quite tight down upon the lid. However, it is a very good makeshift.

Other Rattling Noises.

457 A common cause of rattle is the undershield, and this often vibrates at certain speeds so as to come into contact with oil-pipes or the speedometer shafting, or the latter vibrates and taps against the undershield. An elusive rattle in the neighbourhood of the undershield was traced to a bolt which had been left in the undershield by those responsible for the assembling of the car. The speedometer-shaft is very often responsible for quite a loud noise at certain speeds.

One effective way of stopping rattling on existing joints is to make room enough for a washer in the joint. Fit this washer in while it is flat, then slightly curve the washer similarly to the one that will be found on the well-known King Dick spanner. Now, if the washer be taken and heated up on the forge and smothered with a little prussiate of potash or cyanide and plunged in water it will become a pretty stiff spring, and forced in between the joints it will tend to retake its curved form and stop the rattling for a very long time. Of course, a little graphite grease would be a good thing if the joint works at all.

Back Axle Tension Rods.

458 It is well to examine the back axle tension rod from time to time. When these rods fail, it is usually in the thread of one of the nuts at either end, so that it is quite possible for the rod to be useless as a tie-rod, though it may appear all right unless carefully examined. The mission of the tie-rod is to keep the back axle from sagging, and there is no doubt that the vast majority of axles require this support. It would be possible to make them so that they did not require a tension rod, but only by making them much heavier. In other words, an axle with a tension rod is a more scientifically designed construction than one without, as it can be made lighter and equally strong. The designs vary, and, with them, the details, but damage may be done to the bearings of many axles if the tension rod be broken and the axle left free to sag. The best way to refit a tension rod is to put a jack under the differential case and elevate it till the weight is nearly off the tyres. Then the nuts which tension the tie rod should be

screwed home—not hard but just home, for if the tension be greater than this it merely puts a needless strain on the axle, and not only sets up internal friction, but probably results in the tension rod breaking again before very long.

Tar Paving.

459 The following recipe for making tar paving, taken from *The Surveyor and Municipal and County Engineer*, may prove useful to some of our readers who intend making tar pavings of their motor houses, etc. : The best tar paving is composed of Kentish ragstone or Derbyshire limestone, mixed with a due proportion of tar composition. The stone should be machine-broken, and screened to about an inch for the bottom coat and three-eighths of an inch for the top coat. The stone is heated on firebrick driers, or iron plates with fires burning underneath, and mixed with the composition while still hot. One of the compositions in general use consists of twelve gallons of tar, half a hundredweight of pitch, and two gallons of creosote to every ton of screened material, the ingredients being mixed together and boiled in cauldrons. When applied to the stone, care must be taken that every particle of the stone is covered, and all finished material should be kept in stock for about two months to mature. With the use of hard materials there is always the danger of a " bumpy " path ; but some very excellent pavings have been made with a bottoming of gravel, finished with a topping of granite, both materials being carefully broken and screened, as mentioned above. It is of the highest importance that the stone be thoroughly dry before applying the composition, that the foundation upon which the path is to be made be also dry (three inches of brick rubbish should answer the purpose), and that the laying be not performed under the influence of a hot sun. Each coat must be rolled, and when completed the surface should be " dusted " with a generous sprinkling of Derbyshire spar, or other fine grit or stone dust ; and if the same process be repeated, accompanied with a painting of tar (applied with ordinary tar brushes), once every year or two, the life of the paving will be proportionately prolonged. The surface of this paving can readily be kept clean.

Lights without Matches.

460 Many motorists would imagine themselves in evil case if, when ten miles from anywhere, with night coming on, they found themselves without matches when it became necessary to light up. But let them not despair. Their ignition will come to their aid. The method of procedure is as

follows: Detach one of the high-tension wires from its sparking plug, and attach it to a spare plug, which you will allow to repose upon any convenient part of the frame, so that the high-tension current can earth readily. Now place in the spark gap of the plug a piece of tissue paper, cigarette paper, dry grass, or straw, which has been previously dipped in petrol. Then switch on and turn the engine round until the high-tension current flows to the plug on the frame, when the spark leaping the gap will fire the petrol on the paper or other material, and your much-desired fire is obtained.

Fitting or Removing Studs.

461 It is occasionally necessary to fit in a stud or remove it from some part of the motor car mechanism. If pliers be used they either damage the thread or the plain part of the stud. If the stud be tight and has to be removed, it is often impossible to do this by means of pliers.

A better way is to use a pair of lock nuts which are run on the top side of the stud thread and locked up together, two spanners being used for this purpose. If the stud has to be removed, the bottom nut is then turned by the spanner in a direction counter clockwise when looking on the top of the stud. If the stud has to be tightened, the top nut must be turned in the clockwise direction.

Another method that may be employed when fixing studs in place is to use a rather deep nut with a set screw; run a few threads of the set screw into the nut, and then if the nut be screwed on the top of the stud and held by a spanner while the screw is run down to lock it, the stud may be run into place by operating the set screw in a clockwise direction.

Removing Broken Studs.

462 However carefully nuts are tightened a stud may occasionally be broken off short in a casting or some other part of a motor car. It is usually a difficult matter to remove the broken piece, so that a new stud may be inserted.

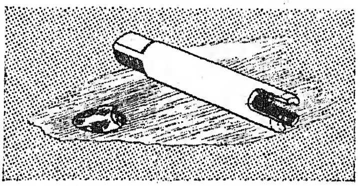
The best way to go about the removal of the broken portion is to drill a hole in the centre of the part broken in. This hole should be of a certain size depending on the diameter of the stud. For a $\frac{3}{8}$in. stud a bare $\frac{1}{4}$in. diameter hole should be drilled, care being taken to drill right down the centre of the stud so as not to damage the thread. A flat-nosed drill should be used, and should be ground so that it only cuts when rotated in the left-hand direction, and not in the right, as the usual drill is ground. The reason for this is that if the stud thread be at all slack, rotation of the drill and the cutting action

will tend to screw out the stud, which will very often come out readily before the hole is drilled very far.

If the stud does not come out as described, then, after the hole is drilled through it, a square reamer is lightly driven into the hole. A lathe carrier is fixed to the top of the reamer and the stud twisted out by rotating the carrier anti-clockwise. If the drilled part is very fast and then will not readily come out, the only thing to do is to chip the broken part with a sharp round-nosed chisel. This usually has the effect of cracking the skeleton of the stud, and the pieces can be fished out of the hole with a piece of bent wire.

Removing a Broken Tap.

463 The extraction of a tight tap broken flush with the face of the metal being operated upon may present some little difficulty to a novice. First try to back it out (unscrew it) with a small nail punch and a hammer. If unsuccessful, take a short piece of round steel rod of the same diameter as the tap, and drill a hole down one end the size of the central portion of the tap. Then file the end to leave three or four short prongs, one for each groove of the tap. Insert the prongs in the grooves, when, if not very tight, the tap may be backed out. If that fails, a drill must be used. If practicable, place the part in a fire, heat to a dull red, and bury in dry lime or sawdust to soften the tap, or leave in the fire until the latter is extinct and the part cool. Then send in a drill the size of the central part of the tap, and with a small chisel pick out the remainder. Should it not be practicable to heat the part in a fire, use a blow-lamp, and, failing that, a candle and blow-pipe. The tap *must* be softened, or the drill will make no impression upon it. Turpentine will be the best lubricant for the drill.—MAURICE GANDY.



Removing Stubborn Nut by Heating Spanner.

464 A good method of removing a stubborn nut which has defied all efforts to unscrew is it as follows: Take an ordinary open spanner that fits the nut, heat it, and place it on the nut, and let it rest there for two to three minutes. The heat will expand the nut, and it will screw off easily. If no fire be handy, the spanner can be heated in a blow-lamp

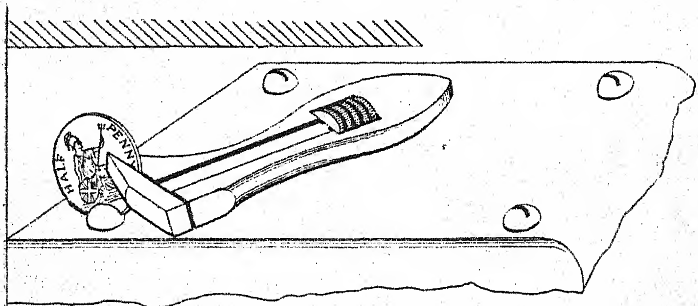
flame. It may be asked why the blow-lamp should not be used to heat the nut direct, but the objection to this is that the bolt is also heated so that it expands as well as the nut. The hot spanner dodge is a very old one, though not generally known. We need hardly say that an adjustable wrench should not be employed, as such a tool is hardened, and would be rendered unfit for use by being heated.

Tighten up Nuts Carefully.

465 Tighten up nuts carefully in order to avoid over-straining the thread. If small nuts are tightened up with a big spanner, the screw is frequently sheared clean off. A 5in. spanner is quite large enough to tighten up a ½in. bolt or nut. For larger nuts add 1in. of leverage to every ⅛in. increase in the diameter of the bolt or nut.

To Tighten Awkwardly Placed Screws.

466 We were once driving a car upon the engine of which is placed an oil circulating pump, this having a cover attached to it by means of six ordinary screws, which screws were placed in such a position with regard to the end

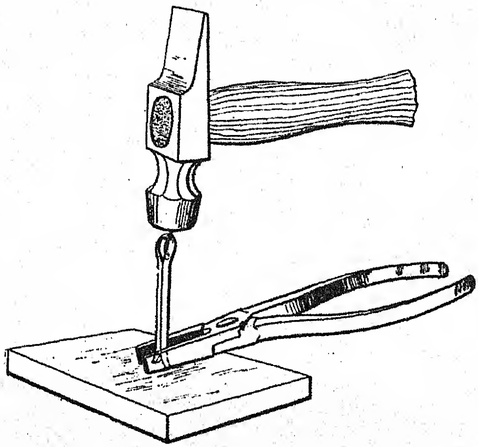


of the crank chamber as to render them inaccessible to the ordinary screwdriver. Noticing that the lubrication system was not functioning properly, and was evidently suffering from a lack of oil, a halt was made for inspection purposes. It was found that the screws securing the cover to the lubricating pump aforesaid had become loose, and that oil was escaping in large quantities. It being impossible to tighten the screws in the ordinary way, other means had to be resorted to, and these were found in a humble halfpenny and a small adjustable screw spanner, which were applied in the manner illustrated. The slotted heads of the screw were, fortunately, rather

wide, so that the edge of a worn halfpenny entered the slots quite easily. With smaller slots something thinner than a halfpenny could be used.

To Straighten a Split Pin.

467 When assembling parts in which split pins are used, it is quickest to use new pins, and not those which have been removed in taking down the parts. Sometimes, however, the old pins have to be used, and difficulty is experienced in straightening them. A procedure which is generally effective is that illustrated in the accompanying drawing. It

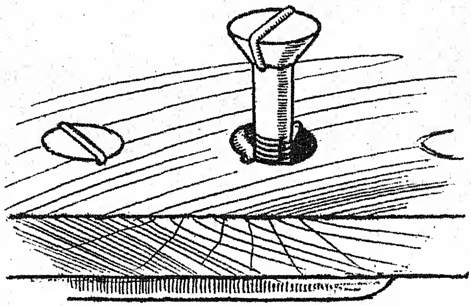


consists in gripping the splayed ends of the pin between a pair of pliers and resting the ends upon an anvil or other hard surface. A tap on the head of the pin spreads that end and closes up the other end, straightening the pin and restoring it to its original shape, so that it may be replaced easily.

To Prevent a Bolt Turning.

468 In going over the various points of the car that were showing incipient signs of rattling, believing thoroughly in the application of the following proverb to the question of rattling, viz., "A stitch in time saves nine," I found that the lamp bracket on the dashboard was working loose. On proceeding to tighten it I jound the whole bolt revolved, and, unfortunately, the head, which was countersunk into the wooden dashboard, was covered by the wind-

screen attachments. There was no help for it but to remove these, but when I had done this I discovered that there was no slit in the head for a screwdriver. This was soon supplied by means of a file, and though the slit would serve for the immediate want, I thought it advisable to make provision for the future, and, having no drill handy, I was unable to



insert a pin. I therefore continued the slit through the corners and hammered a piece of copper wire into the slit and down the sides. This copper bedded itself into the wood, and proved an effective preventive to turning.—C. E. HODGKIN.

Nuts Loosening on New Cars.

469 The owner of a new vehicle should be most careful to examine particularly the nuts and bolts all round the car, either before going out or after returning from a run. No matter how firmly the nuts and bolts may be tightened up at the time of erecting the car, the vibration met with upon the road will be almost certain to loosen some of them, and if these are not attended to an accident may easily occur.

The Use of Spring Washers.

470 There are a number of places on a motor car where it is desirable that, whilst being properly secured, the parts may be capable of being taken down readily. As is well known, the ordinary nut has a great tendency to shake off on the smallest provocation, and possibly allow some part to come adrift when least expected. On the covers of gear boxes, engine hand-hole covers, and any inspection holes or grease plates, it is necessary occasionally to remove these for an inspection of the parts, or for placing therein grease or oil. In such a case the familiar type of split spring washer placed under the nut, which can then be fairly tightly screwed

up, is the most satisfactory method, and, furthermore, there are then no small split pins to take out, and on cleaning the car the ends of the split pins are not there to cause scratching of the hands, this being a common experience where split pins are largely used in these places. The usual split pin fitted to the car is a bad offender in this respect, however carefully turned over and unobtrusive it is made.

Asbestos Washers.

471 When remaking a joint where it is necessary to use an asbestos washer to secure a perfect joint, a good tip is to have a selection of washers which have been previously cut to correct sizes and then soaked for some six or eight hours in olive oil, this being allowed to drain off the washer, the remainder drying upon it to a certain extent. After remaining for some hours for draining and drying purposes, these washers should have a quantity of fine blacklead rubbed well into their surfaces, when they will be ready for use. The advantage of so treating asbestos is that when it is necessary to break the jointing the washer comes away from the surfaces perfectly clean, thus doing away with the necessity for scraping off the fragments remaining, and is fit for use over and over again, so that the treatment facilitates the remaking of a joint, and at the same time is economical, even though it be a petty economy.

Weighing a Car.

472 Many car owners would like to have their cars weighed under their own eye, and this they may easily get done wherever a public weighing machine can be found. The goods depots of the railway companies are generally equipped with a machine upon which cars may be weighed. The car should first be run wholly on to the weigh-table, and the weight noted, after which it should be weighed with the front wheels only on the centre of the table. The weight should again be taken with the back wheels on the table, in the centre as before, when, if the sum of the two last results is within twenty odd pounds or so of the first result, the weight may be considered as having been correctly taken. In ordering tyres for a car, the vehicle should be weighed as suggested, with a full complement of passengers, all tools aboard, tanks full, and load in the car equivalent to the maximum likely to be carried at any time. The tyre makers will then have no difficulty in recommending suitable tyres.

Keeping the Starting Handle Clean.

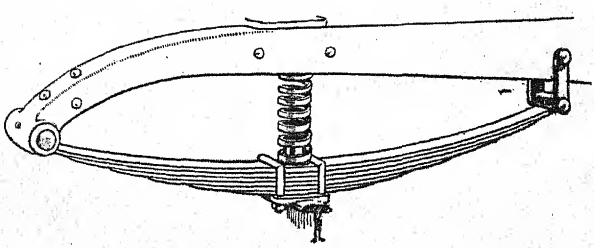
473 Motorists who are troubled with a perpetually dirty starting handle should have made a stiff leather cylinder (like a whip socket), closed at one end, to slide over the hand grip, with a buckle strap attached to sling the handle up to the frame. These can be bought ready-made at most garages.

How Not to Store Goggles.

474 Goggles that are not likely to be used for some time should not be hung up on a convenient peg by the elastic webbing, as it will be found that when next worn they will not fit. This is due to the webbing stretching permanently to an extent which necessitates the clips being readjusted, with the result that the metal buckles come in contact with the back of the ear or the tender part just behind the eye. The cure is obviously new elastic webbing if the goggles are of an expensive pattern. If the goggles are of a cheaper variety, it will be found less troublesome and more satisfactory to purchase a new and better pair.

A Shock Absorber.

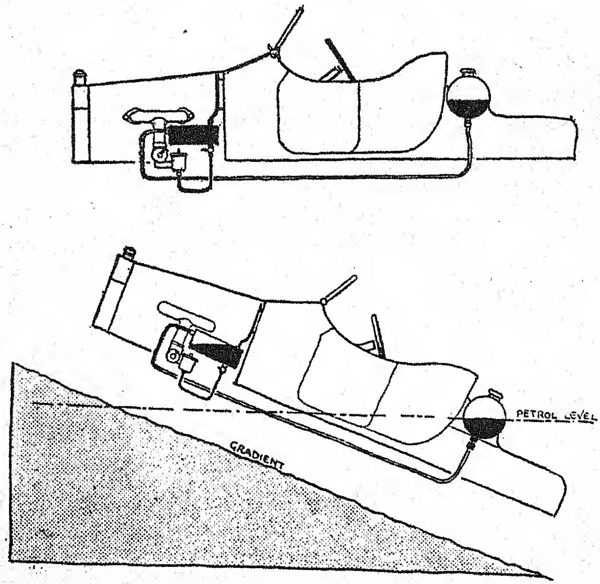
475 I noticed in a recent edition of *The Autocar* that you give an illustration of a spring shock absorber invented by Mr. James Pyatt. I am sending you a free-hand



sketch of a similar thing I had made for my front axles about twelve months ago, and which is still in use. The only difference is that my springs are of the square section and are constantly in contact with the under portion of the frame, and are slipped over a metal pillar which allows of their readily and easily being taken off without having to undo the D bolts holding the springs. I used to have round rubber buffers, but find springs far better.—P.S.D.

Maintaining a Head of Petrol on Hills.

476 The sketches accompanying this show a simple yet effective means of maintaining a good flow of petrol to a carburetter when the petrol supply is by gravity from a tank placed at the rear of a two-seated car.



Two views of a car with an auxiliary petrol tank under the bonnet.

It is often found that to ensure a good supply of petrol to the carburetter, where this arrangement occurs, it is necessary to place the tank at an unsightly height at the back of the car, if the petrol supply is not to be restricted on a steep gradient. As will be seen from the sketches, the system involves the use of asm all additional tank, about 9in. × 4in. × 4in., placed under the bonnet in a convenient position near the carburetter. The bottom of this small tank must at least be level with the top of the float chamber. As shown above, the petrol connections must then be as follows: (1) A pipe leading from the bottom of the large tank to the top of the small tank at the end nearest the radiator; (2) a pipe leading from the bottom of the small tank at the end nearest the dashboard to the

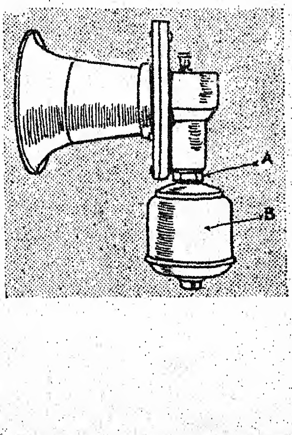
carburetter ; and (3) a small section vent pipe from the top of the small tank. It is advisable to place the petrol tap somewhere in the pipe between the small tank and the carburetter, in the most accessible position for general use. As will be seen, if the large tank be a few inches above the level of the small tank, it will keep it filled when the car is on level ground, and also when going downhill ; therefore, on a rising gradient, when the carburetter is normally starved, or receives a restricted supply from the large tank, the small tank will supply petrol while any remains in it. If it be made of reasonable dimensions, the small tank will supply the carburetter for several miles, and hold enough petrol to take the car up any hills likely to be encountered. When the level ground is reached, it automatically refills. It is advisable to have a small cock in the vent pipe of the auxiliary tank to prevent an air-lock when it is first filled, and also, as usual, to have a small vent in the filler of the main petrol tank.

The lower sketch shows the relative positions of the two tanks and the carburetter when the car is on a steep gradient. It will be seen that in the exaggerated position of the car in the sketch, the larger tank is actually below the level of the carburetter, while the petrol in the small tank is still sufficiently above the carburetter to maintain a good supply.

This system could be adopted with advantage on many cars having a gravity tank under the front seat, but the top of the extra tank must be at least level with the bottom of the large tank, while the former must be above the float chamber when the car is level.

I may state that I have recently carried out this idea on my own car, and find it quite satisfactory in every way.—Stanley N. Matthews.

The Klaxon Horn Adjustment.



477 To the uninitiated the adjustment of a Klaxon horn is a matter of some difficulty. Really it is a very simple operation which rarely requires carrying out. Just above the motor casing is a union nut A. This has to be slacked off, and the motor casing B rotated slightly. It will be found that different angular positions of the motor

casing B produce different tones. These horns require very little attention, and an occasional drop of lubricating oil in the lubricator on the top of the horn is all that is necessary.

Cleaning the Klaxon Horn Commutator.

478 Writing in reference to the " Hint and Tip " on the above subject, the Klaxon Co. say: " We would like to point out that the writer has missed a very important item, viz., that of cleaning the commutator every month or six weeks. This really is more important than the lubrication at the top of the horn, as mentioned in the note. To carry out the cleaning of the commutator, remove the bottom plate, which is held in by four screws. This exposes sufficient of the commutator to allow it to be reached and cleaned by a rag on the end of one's little finger. Having cleaned the dirt off, then a very little vaseline lightly applied with the finger is all that is required. If, however, this is not done regularly, the owner of the instrument is laying up trouble for himself in the long run, as after using it six months or so the commutator would be so caked that the current would pass very sluggishly, and the motor would not turn at its required speed."

Soldering Cast Iron.

479 It is often asserted that cast iron cannot be soldered, but the following plan has been found satisfactory, provided, of course, the part be not afterwards subjected to excessive strain or heat. Clean the part to be soldered with a brass scratch brush, then apply the soldering acid and cover the surface, following this with a thin coat of tallow by heating the cast iron just enough to melt the tallow. The part is then ready for soldering with an ordinary bit and the usual acid.

Tapping Stud Holes.

480 When tapping a hole to take a stud, the tap must be maintained perpendicular to the face, or the stud will need to be set square with a nut and hammer when in place. To keep the tap square during the operation, put a nut on it and run that down against the face surrounding the hole, and it will show at once in which direction the tap inclines. If much out, work the wrench or bar to bring the tap square, and then allow the nut to bear against the face. If the nut lock when working it in, reverse the latter to release it, move the nut back a little, send the tap down again, and continue. This will be found better and easier than the usual way of working the tap to a try-square or by mere judgment, but care must be taken, as small taps are fragile, and will snap without warning.

A Simple Number Plate.

481 A very cheap number-plate of good, lasting qualities can be constructed from a strip of patent leather upon which the number is either painted or applied by means of transfers. The patent leather always keeps a fine gloss, and cannot rattle. It may also be easily attached to the body by means of screws or staples.

Route Markings.

482 I have hit upon a very quick way of laying out routes upon a map. Obtain a few yards of chain such as is used for securing bicycle tyre valve caps to the spokes, which can be purchased cheaply at any ironmonger's, or, better still, the fine chain sold by oculists for pince-nez.

This is placed on the map along the route proposed to travel, and then particulars and place names can be read off and recorded with the least amount of eye strain usually caused by continually losing and finding the last place one dealt with. This will be found specially useful in laying out routes and inter-connecting cross routes. It is very graphic, and the lay-out can be repeatedly changed until the final arrangement is decided on. It is infinitely quicker than inking in routes, and does not disfigure the map.

Another advantage is that if the chain be split up into short lengths, proportionate, say, to twenty or thirty miles on the scale to which the map is drawn, the length of route can be "chained" out and the mileage readily ascertained. The weight and flexibility of the chain keep it down upon the map, however sinuous the route, without the aid of pins.—V. A. HOLROYD.

When Buying a Jack.

483 When a man purchases his first car, he often thinks that any sort of tyre jack will do, and that here at least is an item where strict economy is justifiable. As a result he buys the cheapest jack he can see in the shop. Ere long he discovers that to operate this type, he has practically to lie down under the car—which is unpleasant in wet weather; that the base is so narrow that the car sways in an awesome manner when the detachable wheel is withdrawn from the axle; that the jack is barely long enough, and its protruding stem looks like a factory chimney in process of felling, even when the footboards are placed beneath it to give more reach; that the tiny head affords an insecure resting place for the axle; and that the jack is generally so unsatisfactory that he must hasten to scrap it, and get a really good article in its place.

A good jack should have a large flat base, a broad business end with a depression of deep contour in it, and be so high in its closed position as nearly to touch the axle without extension when the tyre is flat. Above all, it should be operated by a loose handle quite 30in. in length, projecting at right angles, so that recumbent positions are not necessary.—B.H.D.

Lighting Paraffin Lamps.

484 I have found that the lighting of a paraffin lamp may be considerably facilitated, especially when a high wind is blowing, by turning the lamp wick up to the extent of half an inch or more above the top of the burner, and then turning it down again to its normal height before striking a match. I think the reason of this is that moving the wick up and then down in this way stimulates the flow of the oil, and causes the top of the wick to become thoroughly saturated before the light is applied.—C.H.B.

Repairing Cracked Water Jackets.

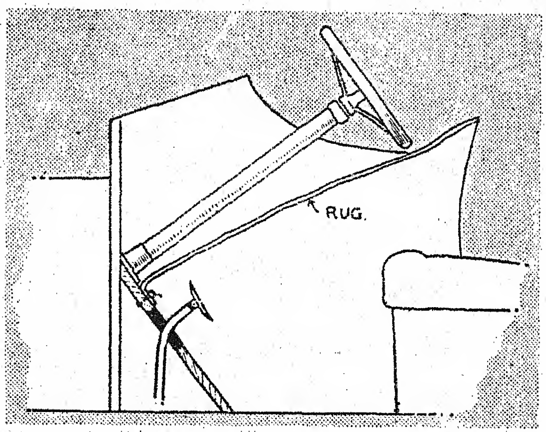
485 Cracked water-jackets are unusual during the summer months, but a tip worth filing for reference when the winter months come round is the following, which was given to me by a garage proprietor recently. Open out the crack in the jacket to a V-shape without increasing the opening on the inner side, then smooth the edges and deposit on them any of the preparations sold for silver plating, and it will be found that solder will readily adhere to the smooth surfaces. The garage proprietor in question showed me a 6 h.p. Rover engine which he had treated in the manner mentioned, and after six months' use the repair is perfect and almost unnoticeable.—G.S.

Worn Throttles.

486 Carburetter throttles of the barrel or sleeve type are liable to wear very rapidly, and any appreciable amount of wear upsets the regular running of the engine at slow speeds by reason of the leakage which occurs, and which it is impossible to counteract by the manipulation of a throttle lever. I have found that a throttle barrel or sleeve so worn can be cheaply made a good fit once more by having it nickel-plated. This process costs only a few pence, and often obviates the necessity for a new barrel. The process would not, of course, be effective if the throttle had worn so much that a good deposit of nickel would not bring it up to the required size. In the event of the throttle barrel having worn oval, it could be plated all over and the nickel scraped off again from the portion which had not worn away.—R.E.M.

A Rug Tip.

487 During the cold weather I fixed one edge of the rug along the footboard of the front seats just above the pedals, as shown in the accompanying sketch. This held the rug free from the pedals, whilst, as the car was fitted with an exhaust-heated foot-warmer, the air space beneath the rug



was filled with warm air and kept the whole body warm. The rug was fixed down by screws passing through copper washers. On a previous car it was secured by turn-buttons such as are used on Cape cart hoods, and could then be attached or removed in a few seconds.—E.W.

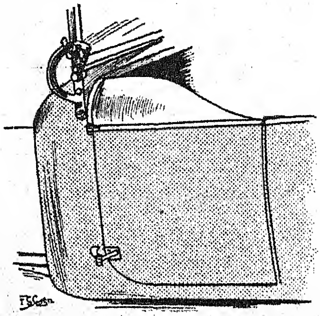
To Remove Water from Petrol Tanks.

488 The motorist is continually advised to take care that no water is mixed with his petrol, and to use a gauze in the petrol funnel which will pass the petrol but not water. However, occasionally water is put into or finds its way into a petrol tank, and difficulty is then experienced in removing it. This particularly refers to gravity tanks, which do not usually have a sump to catch impurities in the petrol. A good plan to remove a small quantity of water from a tank is to take a wet chamois leather, wring it out thoroughly, and make a pad of it at the end of a stick. If this pad be inserted in the filler

orifice of the tank, it will pick up any water with which it comes into contact. It will often be found that even if the tank be detached, it is impossible thoroughly to clear it of water without some such aid as that suggested.

Wind Deflectors to Doors.

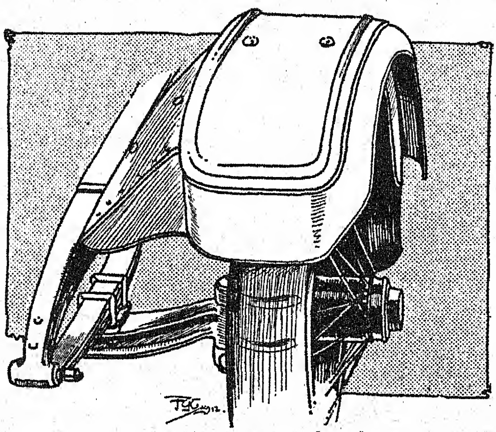
489 Nothing conduces more to comfort than a hinged scuttle or lid to both the back and front seats of a car, but these scuttles are always a nuisance when getting in and out of the car, particularly in the case of the front seats. We have overcome the difficulty on one of our cars by having the dashboard and screen brought as far back as possible without interfering with the door, while the door itself has a curved wing fitted to it. This wing is made of sheet steel, and is firmly bolted along the top of the door, so that it is a part of the door, and opens and closes with it. The sketch



shows its construction so plainly that very little explanation is necessary. The form of the curved extension can be varied to suit the design and dimensions of the car, but wings no larger than the one we show keep out cross draughts exceedingly well. On the opposite side of the car there is no door, so that the wing extension on that side is fixed, not only to the side of the car, but also to the dashboard. If desired, this wing on the driver's side can be considerably larger, and may extend as far into the car as convenient; of course, the bigger it is, the more protection it will afford. The metal wing extension to the door is not only far more sightly, but far more useful than the absurd little bolsters or upholstery rolls which some people insist on having put on their doors, as though the doors were intended for seats.

A Mudguard Improvement.

490 We once found that the front wings of a new car were passing a great deal too much mud, so much, indeed, that not only were the side lamps and driving screen smothered, but the mud drifted right back on to the outside edges of the back seats, while the fronts of the back wings, just where coats and skirts of passengers would touch them in getting in and out, were absolutely smothered. The wings were already fitted with the usual deep vertical flange or lip on the outside, and we found that the mud was collecting on the outside of this, and then blowing back. We therefore came to the conclusion that the best thing to do was to provide a means



A double flanged mudguard.

of catching this mud when it blew back, and fitted a curved extension to the existing mudguards, leaving the old outside flange in position. This has been most successful, as the mud which gradually collects upon the inner lip blows on to the curved addition, and then harmlessly trickles down inside it, so that now the car keeps exceptionally clean, even on the water-logged roads which have been so prevalent during the present winter. Although shown in the drawing, we should add that the addition to the mudguard is not merely along the outside; it extends right round the front, so that the mud which collects on the inner front lip is also prevented from blowing back by the outer lip, which, it will be seen, is very deep, projecting at an angle somewhat forward of the main

mudguard, and more or less like an inverted sugar scoop. It is necessary that the curved extension should always come down to and slightly below the running board, so that the mud which collects upon it and runs down inside it may drift under the running board and not above it. Unless this little point is borne in mind, the transformation will be a failure to a very large extent.

Case-hardening.

491 Case-hardening can be done in an open forge fire by using either potassium ferrocyanide [$K_4(FeC_6N_6)$, $3H_2O$], or a special case-hardening mixture. The Glacier Anti-friction Co. sent me a sample of a good mixture some time ago, and I am now using a mixture called Kasenit for some kinds of work. The process is only suitable for small work which only requires a thin case. The method of procedure is very much the same either for potassium ferrocyanide or for a special mixture.

If nitrogenous matter, iron and potassium carbonate, be fused together, commercial potassium ferrocyanide results, and a mixture of leather, hair, potassium carbonate, and a little potassium ferrocyanide will have much the same effect as potassium ferrocyanide alone, the advantage (if any) being that the work is more easily kept clean during the process. The ordinary method of case-hardening with potassium ferrocyanide is as follows:

Heat the article to a bright red, plunge into finely powdered potassium ferrocyanide, and keep covered with potassium ferrocyanide until it has cooled out to dull red, then plunge into cold water, and agitate. This process requires considerable skill, and the work will be burned if care is not taken.

The general method when using a case-hardening mixture or compound of any kind with an open furnace or a brazing hearth is as follows:

For malleable, cast, wrought iron, and mild steel.

(1.) Malleable or cast-iron. Heat to a white heat. Dip into powder and keep covered with powder until a thick coating sticks to the article wherever it is required to be cased. Heat up again and keep adding enough powder to cover the article. The heat may be lowered to dull red during the process. This process should proceed for about twenty minutes, and it is more convenient if casing a large quantity to bury the articles in the powder in an iron tray and heat the whole lot up together. The articles should finally be heated up to bright red and quenched. The adhering scale should be cleaned off before removing the articles from the water.

(2.) For wrought iron and mild steel. Heat to a full yellow colour, cover with powder, and proceed as in (1). The depth of the case depends upon the time of heating. The time generally varies from five to twenty minutes.

(3.) For cast steel. Heat to a bright yellow, plunge into powder until bright red. Keep the article covered with powder, and the heat above dull red for a few minutes. Then raise to bright red and quench. Remove the scale as before.

The advantage of this process seems to be that it is quick and will produce a hard case on such articles as bolts and nuts, wires, pins, small shafts, collars, small races, and numerous other small parts which often require to be hard, but which do not have any great wear on them. For a thick case, however, furnace case-hardening is necessary.—HORACE C. HEYWOOD.

Refilling Oil Tanks, etc.

492 Both chauffeurs and owner-drivers often grumble at the time required in running viscous motor oils into their proper receptacles. Engine oils run fairly freely, provided the tank has a fair sized aperture, but the coarser oils used for axles and gear boxes, and the thicker varieties used for the high-speed engine, often trickle very slowly. The propensity of a very gentle heat applied for a few minutes to thin such oils almost to the consistency of water is not often taken advantage of. I suppose it is overlooked because these oils are known neither to burn nor vaporise except at high temperatures. It used to take the writer an hour to charge the back axle of his car with the oil recommended by the makers. Nowadays, the can of oil is placed on the kitchen stove for ten minutes before approaching the car, after which the axle may be charged as quickly as though it were lubricated with petrol. The tip applies also to the filling of dash lubricating tanks which have small apertures, and to putting up a spare supply in a gallon can, which seldom possesses an orifice of generous dimensions.—B.H.D.

Tyre Pressures in Hot Weather.

493 We fear the majority of motorists do not give enough thought to tyre pressures. Under inflation is as bad and as injurious to the fabric of an outer cover as over inflation, and both can only be detected by the frequent use of a thoroughly reliable tyre gauge. The gauges on pumps are for the most part quite misleading, and cannot be relied upon. But if pressures should be considered in the ordinary way, much more then should they trouble the mind of the careful motorist in hot weather, particularly such as we enjoyed during

the summer of 1911. We had an example of this one day when the shade temperature in some parts of the country reached 92° F. Starting for a hundred miles drive to London, our back tyres—820 mm. × 120 mm. steel-studded Michelin—carrying between them 12 cwts. 28 lbs. plus passengers and baggage, showed 70 lbs. per square inch. Twenty-two miles further on, our passengers in the rear of the car having complained much of the jolting, we stopped and found our tyres so hot that it was barely possible to hold the hand on them. Testing them with the Michelin tyre gauge, both tyres showed not 70 lbs. per square inch, but actually 85 lbs., an increase of pressure due entirely to expansion. The front tyres had gone up 8 lbs. to 10 lbs. per square inch, and had also to be let down. The moral of this is that in hot weather, though one may set out with proper pressure in one's tyres, it is very desirable, if comfort and wear are to be obtained, to test the pressures again after some distance has been covered, and to release the excess of air.

Hooter Troubles and Repairs.

494 The chief trouble to which hooters are liable is the splitting of the horn bulb. One of these days makers of these bulbs will produce a reinforced construction which will not split, but meanwhile all that we can hope for is the selection of better rubber in their manufacture. Various accessory makers supply bags or jackets which can be fitted to the bulbs, protecting these considerably. Other makers supply special concave patches to suit the shape of the bulb, enabling the latter to be patched in the same way as a tyre is patched. The strength of horn bulbs is not very great, so the split is liable to increase rapidly unless it is patched at the earliest possible moment, and for this reason directly the smallest hole appears a good sized patch should be applied.

The process is practically the same as that of tyre repairing, and quite as much, if not more, care should be taken to clean thoroughly and to roughen the surface of the bulb. Two or three successive coats of solution should be applied, allowing each to dry before the next is laid on. A Patchquick patch of good size will then hold on well for some time.

A speck of grit in the reed will render the action of the horn erratic, or put it out of operation altogether. In such a case the reed should be taken out and a piece of thin paper passed under its tongue, taking care not to bend the tongue, which would have the effect of altering the tone of the horn or preventing its working at all.

After washing the car, water very often finds its way into the trumpet, having a similar effect to grit under the reed. A small hole should be drilled at the lowest part of the trumpet, which will not have any effect in reducing the volume of sound, but will prevent the collection of water.

To vary the note of a horn, a small piece of solder should be fixed to the reed, which will cause its rate of vibration to be varied, whilst adjustment of the tone can be obtained by adding more solder, or cutting away some of that already fixed.

If the flexible tube break or leak, a finished repair is somewhat difficult to effect, but a temporary patch can be applied by means of a strip of insulating tape or a short length of hose pipe, firmly wrapped round the fracture with copper wire.—E.W.

How to Serve an Oil-drum.

495 Many motorists now save money on their upkeep charges by purchasing large casks or drums of lubricating oil, but they half regret their economical attempt when they come to draw off a tankful through one of the narrow bore brass taps supplied by the factors. My own car demands a very thick oil, and it used to take about ten minutes to draw off enough oil to fill the white enamel quart jug which I use as a transferring vessel between drum and car. My odd man has now knocked together a double X-shaped trestle on which the drum reposes in my shed. The bung-hole is drilled in the end of the drum, and the original cork plug is left *in situ.* A penny corkscrew is sunk in the bung, and serves as a means for extracting it swiftly and cleanly. After I have drawn off supplies a couple of taps from the garage mallet replace it so firmly that the pressure of the oil behind is powerless to shift it again.—B.H.D.

THE CHEMISTRY OF THE CAR.

IRON.—OIL AND GREASE.—WATER.—TYRES.—ACETYLENE.

Iron.

496 A knowledge of elementary chemistry is of undoubted value to the motorist, more especially to the man who takes a personal interest in the running and upkeep of his car, and who is keen on getting his money's worth in the pursuit of his hobby. Motor car manufacturers must of necessity possess expert chemical as well as engineering knowledge. Metals and alloys must be analysed carefully before use, the behaviour of metals under certain conditions must be known; in fact, no pains must be spared to give the motorist the very best. In the running of the car many interesting problems arise, most of which may be explained chemically. The purpose of these notes is to give the car owner a slight insight into a few of the most common chemical problems which present themselves in connection with the actual use of the car.

RUST.

The problem of rust seems a suitable one to begin with, as it is probably the most noticeable and persistent with which the motorist has to deal.

The large quantity of steel (iron) used in motor car construction is, of course, responsible for the condition. Iron and steel under ordinary circumstances are unaffected by perfectly dry air, but when moisture and carbonic acid gas are present (these occur constantly as impurities in air) hydrated ferric oxide ($2Fe_2O_3 3H_2O$) or rust is produced. In the presence of those impurities iron is capable of decomposing water, forming iron carbonate ($Fe + H_2O + CO_2 = FeCO_3 + H_2$). This is dissolved by the carbonic acid gas CO_2, and the solution rapidly absorbs oxygen from the air ($2FeCO_3 + O = Fe_2CO_3 + 2CO_2$), and ferric oxide is deposited in a hydrated state. This is the scientific explanation of the formation of rust.

Professor Crum Brown explains rusting in rather a more simple fashion. Take, for example, a drop of rain falling on a clean bright surface of steel or iron. The drop of water remains clear for a time, the surface of the metal being seen beneath the liquid. Soon, however, a greenish precipitate is formed in the water, rapidly becoming reddish brown. This brown precipitate (ferric oxide or rust) does not adhere to

the surface of the metal, but is suspended in the water, and it only becomes loosely adherent to the metal after the evaporation of the water. Now, rust is hygroscopic, *i.e.*, it extracts moisture from the atmosphere, and once the condition is established it progresses. It does not stop short with the original coating. The ability of the deposit to extract moisture from the air simply permits the process to run riot. Water will condense on rust when it will *not* condense on bright steel.

A similar example is seen in the use of iron nails driven into oak planks. A black streak will be noticed in a sectioned wood block descending from each nail; here we have the formation of iron carbonate (the preliminary stage of rust formation). This carbonate is acted on by the tannic acid in the wood, forming iron tannate—ink. A more homely example of true rust formation is seen in ironmould on vegetable fibre—linen, for example—caused by contact with a nail, iron carbonate being formed, and then by absorption of oxygen from the air, rust. This latter example is of interest, for it is exactly what happens to the fabric of a tyre after contact with a rusted rim.

In addition to the formation of rust there is another interesting chemical reaction—ammonia (NH_3) is formed. This is all the more remarkable, as nitrogen and hydrogen can only form ammonia by direct combination with great difficulty. In the process of rusting, however, the two gases, nitrogen (N) and hydrogen (H), are in the nascent state, and combine quite readily to form ammonia. This reaction matters little to the motorist, the main point being the corrosion and damage done to the metal in rust formation.

The parts most commonly affected on a car are the springs, shackles, hasps, steering knuckles, brake connections, running board hangers, nuts and bolts on chassis, rims of the wheels, and the spoke nipples on wire wheels. In those places water and mud are apt to gather and be overlooked, and rusting is the result. As the process is a progressive one, it stands to reason that prevention is easier than cure, and many methods have been tried to bring about this result.

In 1878 Bower's process was patented. This consisted in depositing a thin layer of the magnetic iron oxide (Fe_3O_4) on the metal, while the deposition of zinc (Zn) (galvanising) is much used in the building trades. The motorist has, however, only paint and grease on which to rely, and the better the paint and grease, the more thorough are their rust-resisting qualities.

There is a very important point to remember in connection with the use of paint for the prevention of rust—the metallic surface should be perfectly clean chemically. It is absolutely futile to paint over an already rusted surface. In the first place the paint will not "bite," and in the second place, the rusting will still continue as a result of the hygroscopic qualities of the ferric oxide. Probably the chassis which resisted rust better than any were those with tubular frames, which were japanned, thus completely protecting the metal in a way quite impossible with paint. When one considers the danger arising from the weakening of the metal by this corrosive process of rusting, and also the vibration, one will appreciate the importance of such parts as steering and brake connections receiving the most special attention. It is customary, for instance, to keep a liberal supply of grease about the steering knuckles, and it is important that the grease should be the purest obtainable.

An excellent object lesson for the motorist is to examine a chassis the body of which has not been taken off for, say, eighteen months or two years. The amount of rusting which has gone on is remarkable, and plainly proves the necessity of frequent examination. The owner-driver of the runabout type of car painted in grey has a distinct advantage over the motorist possessing the more lordly painted and varnished open or closed touring car, for as a rule the light body of the runabout can be easily detached, the rust removed, and the affected parts painted grey without detracting from the "smart" appearance of the car as a whole.

In the removal of rust, say, from the rim of a wheel it is customary to use some substance to soften the deposit—paraffin, for example, which contains no oxygen—and if necessary the very finest of emery paper, then a dressing with alcohol or methylated spirit (to ensure thorough cleaning), and finally a coat of paint.

Oil and Grease.

497 The importance of the correct lubrication of engines and the various moving parts of a car is so obvious that no excuse is offered for suggesting that a knowledge of the chemical and physical properties of the lubricants in use will be of service to the motorist.

The motor engine presents many difficulties which require to be surmounted before correct lubrication can be obtained. We have machinery capable of developing tremendous power in proportion to its weight, extreme heat, sudden changes of

temperature, high piston speed, vibration, and ill usage to consider, to say nothing of dust; all these factors must be taken into account.

Friction.

Friction has been described as "the force which is felt to resist the motion when one body rubs against another while in motion." The friction of quiescence (resistance to the beginning of the motion) is greater than the resistance of its continuance, and the friction of motion is entirely independent of the velocity of the motion. The resistance of friction to a shaft turning in a bearing has evidently a leverage in proportion to the diameter of the shaft. This point is taken advantage of in car practice, where shafts and axles of wheels are made as small as possible consistent with strength.

Resistance that occurs between the circumference of a wheel and the road is known as rolling friction. There is always an obstacle to be surmounted in front of the wheel, and on the principle of the lever larger sized wheels have an advantage over smaller ones. Friction is the constant opponent of motion, which creates heat—frictional heat.

Now, friction absorbs power, generates heat, and causes wear, and the presence of a lubricant is thus necessary in an engine where shafts run in bearings and pistons move in cylinders. Lubrication is a necessity, and is the most important factor in the mechanical world. We have about the most perfect example possible of complete lubrication in the case of the joints of the human body. Every movement we make is only possible by reason of the wonderful provision of nature in supplying an efficient lubricant between the moving bone surfaces; should, by illness or inflammation (rheumatism, for example), a joint get stiff and useless, we have a good simile of the seizing of a piston in an engine.

Oil as a Cooling Medium.

The lubricant between the two metallic surfaces forms —or ought to form—two films, one on each surface; those films serve to separate the two surfaces, and if this were purely a mechanical process, lubrication would be quite a simple matter.

The films of oil absorb part of the heat generated by movement. This heat increases with velocity and continued motion, and were it not taken up and dissipated by the oil, it would be absorbed by the metal, with disastrous results.

Metal is capable of absorbing a large amount of frictional heat, but is unable to rid itself quickly of this heat, so that

lack of lubricant would result in overheated parts and stoppage of the engine. It will thus be seen that lubrication will be efficient only when the work to be done and the frictional heat generated are taken into account.

Where the Oil Goes.

Frictional heat is generated by motion, and it vaporises the lubricant; this was proved by Count Rumford's experiment. Rumford took a metal vessel with a hollow bottom and a perpendicular shaft fitted to it; this was rapidly rotated by mechanical power. The vessel was filled with water, and it was ascertained that after four hours the temperature of the water had risen to 140° F. owing to the absorption of frictional heat; in eight hours the boiling point of water—212° F.—was reached. After this the water began to diminish in bulk so long as the shaft was kept in motion. If oil be substituted for water the oil will gradually reach the temperature of its evaporation point and diminish in bulk.

Lubrication is therefore more than a simple mechanical matter of keeping two surfaces apart. The chemical part of the process consists in the evaporation of the oil, its transformation into a gaseous state, and the dissipation of heat by the oil while in this gaseous state. It is also to be remembered that friction occurs between the two films of oil themselves.

This evaporation takes place in every bearing on a small scale, so small, indeed, as to be imperceptible to our senses. Where a shaft rests heaviest in a bearing there is a line to be drawn where this invisible transformation of the oil from the liquid into the gaseous state takes place. This line is very small, perhaps no more than the thickness of a fine sheet of paper, but on this line the frictional heat starts to be generated, and being taken up by a few molecules of oil at a time, is carried with the vapours into space. Through neglect, bearings may become overheated, and under the rapidly increasing temperature the few particles of oil may vaporise too fast and become decomposed by the iucreased heat, the vapour, with its burning smell, proving the slow and mysterious process by which the oil disappears. (*Dieterichs.*)

Essentials of Suitable Engine Oils.

The physical qualities of a good engine oil may now be considered. The oil should have a high flash point—this is necessary on account of the high temperature in the cylinder. It should remain as oil on the cylinder wall, and the film must be sufficiently viscous to remain an unbroken film in spite

of the high piston speed. It should contain no substances likely to decompose and disintegrate under the influence of heat, as some animal and vegetable oils do, thus forming acids which may be injurious to the metal, causing roughness and friction, and preventing the formation of a film.

The oil should be as thin as possible for the work. Complete lubrication is a practical impossibility—we can only aim at a high state of lubrication. Too thick oil will have a good deal of quite unnecessary friction inside it, and too thin oil (whilst causing the least possible friction inside the oil) may not serve the purpose of keeping the metallic surfaces apart.

The oil should be odourless, not prone to " gum up," and should remain reasonably fluid at low temperatures. This is of importance, more especially in engines of earlier types where the lubrication is effected through small bore pipes with sight feeds on the dash.

A good cylinder oil ought to lose little or nothing when kept at a temperature of 212° F. for twenty-four hours; a loss of 1% should be sufficient cause for rejection. It should also possess the property of adhesiveness to hot metallic surfaces.

The basis of most cylinder lubricating oils is petroleum, a natural product which has been known from very early times, and found in nearly all geological formations. Hence its widespread distribution over the globe. Petroleum varies in its crude form according to its place of origin. When found near the surface of the earth the deposit is almost solid, or is a liquid of heavy specific gravity. This would seem to indicate that some filtering or evaporation had occurred, the more liquid portions percolating to the lower strata of the earth. The deeper the bore the more fluid is the crude oil that is found.

Certain crude oils are said to be quite suitable for cylinder lubrication after the simple treatment of the product with steam, introduced at the bottom of the still. As the oil emerges from the wells large quantities of illuminating gas are given off, principally ethane (C_2H_6), and use is made of this for heating and lighting purposes. The oil also contains a quantity of ethane in solution.

On distilling the crude product, ethane, propane (C_3H_8), and butane (C_4H_{10}) are liberated in the gaseous state. These are collected and subjected to the action of a condensing pump, when the liquid known as cymogene is formed. This is used in freezing machines to produce an intense degree of cold owing to its rapid evaporation; it consists chiefly of butane.

The liquid constituents of the petroleum are separated by a process known as fractional distillation, which depends entirely on the difference in boiling points of their constituents.

The part which distils over, below 76° C., consists chiefly of pentane (C_5H_{12}) and hexane (C_6H_{14}), and is known as petroleum spirit—petrol. The next portion of the distillate is chiefly heptane (C_7H_{16}), and is known as paraffin oil. Oils whose boiling point is below 76° C. are not safe for burning in lamps, as they so easily evolve vapour which forms an explosive mixture with air.

The portion of the petroleum which distils over between 150° and 300° C. is made up of nonane (C_9H_{20}) and dodecane ($C_{12}H_{26}$), and this forms the basis of petroleum lubricating oils.

At higher temperatures still, the liquid which distils over consists of hexadecane ($C_{16}H_{34}$) and other hydrocarbons richer in carbon; these form soft solids—vaseline—and those containing most carbon form wax-like solids—paraffin wax.

As a result of the distillation of, say, Pennsylvania crude petroleum, we get the following:

Naphtha	4.3%
Burning oil	44.2%
Lubricating oil	45.7%
Paraffin (solid)	2.7%
Coke	2.2%
Loss	.9%

There are three distinct kinds of petroleum lubricating oils. (*Hurst.*)

(1.) Dark Cylinder Oils.—These possess great body, and are obtained from the crude oil by the distillation process which frees them from volatile oils, and they are then filtered in order to remove paraffin and gritty matter. (The term paraffin here means the solid wax-like substance, not the paraffin oil used for burning.) Paraffin wax is extremely detrimental in a lubricating oil, as it becomes quite fluid and limpid at high temperatures and has no lubricating properties, though solid at ordinary temperatures. These oils vary much in consistency. Some are fluid, others semi-fluid. Their colour varies from brown to black, and all have the characteristic bloom of petroleum oils, which is of a greenish colour. These variations will depend on the source of the crude product and on the refining process.

(2.) Pale Cylinder Oils.—These are also prepared by distillation. They are of a brownish yellow colour, and fluid. As a rule they have not sufficient body to be used by themselves for engine lubrication.

(3.) Filtered Cylinder Oils.—These are prepared by filtering the oil through charcoal. They are solid, like vaseline, and possess a greenish bloom and brownish colour, but they are not such good lubricants as the darker oils.

The leading authorities on the subject state that the best oil for the purpose of lubricating internal combustion engines is a pure hydrocarbon oil having a high vaporising point, viz., 260° F., a flash point of 430° F., and a fire test of 550° F. All these conditions can be fulfilled by petroleum products. As a test, take a sample of oil, pour out, say, 4 ozs. into a wide-mouthed glass bottle, and shake it thoroughly. This will give a rough idea of the composition and qualities of the oil from a few simple observations. The turbidity will show the presence of water or of oils which do not mix perfectly. A sediment will most likely be stearin or dirt; note the colour—from straw, lemon, wine red, to opaque. The "bloom" indicates the presence of mineral oil. To experts the odour and taste may reveal much concerning the source of the oil under observation. Fish oils when warmed have an unmistakable odour; whale oil is detected by its "nutty" flavour. By inverting the partially filled bottle and noting the manner in which the oil runs off from the bottom and the number of drops, an approximate idea of its viscosity may be obtained.

The best test, however, is by practical trial in the engine itself. It is a matter of great comfort for the motorist to know that there are so many first-class lubricating oils on the market from which he may make a selection. Presuming, however, that he is unlucky enough to come across an unsuitable oil, it is important to note that fresh oil of another make should not be added to the crank case before thoroughly washing out the engine with paraffin oil. Clean, good oil put into a dirty engine with gummed-up bearings has simply no chance of asserting its superiority under the unfavourable circumstances. It has first of all to get rid of the gumming round the bearings before its lubricating qualities will be manifested. Once the engine is accustomed to an oil which functions properly, that oil should be always used, and none other.

At least one firm of British oil manufacturers issues two kinds of oil for motor engine lubrication—one a pure hydrocarbon, the other a mixture of hydrocarbon and fatty oils. The firm in question has done such a lot of experimenting on the matter with such happy results that there can be no question of the value of the oils it issues, whether hydrocarbons pure and simple, or mixed with fatty oils. One gas

engine experiment showed that the fuel consumption was lowered and the friction reduced when the compound oil was used, and also that the addition of the fatty oil produced a better all-round lubricant.

The Origin of Fatty Oils.

We have touched on only one of the two classes of oils in common use—the oils derived from the treatment of the raw product known as petroleum. These are the hydrocarbons, composed of hydrogen and carbon. There is another great class, however, viz., the fixed or fatty oils, composed of oxygen, hydrogen, and carbon.

The sources of origin of this class of oils are the animal and vegetable kingdoms. The vegetable and animal oils and fats have been named by chemists glycerides, because by the process of saponification they can all be made to yield glycerine. This glycerine is not present in the oils as such, but in the form of the radicle glyceryl (C_3H_5) in combination with certain acid bodies, like stearic and oleic acids, which are known as fatty acids on account of their occurring in the various oils and fats.

The most common vegetable oils in use for lubricating purposes are: Almond oil, palm oil, cocoanut oil, olive oil, and rapeseed oil. Animal oils: Lard oil, sperm oil, tallow oil, neatsfoot oil, and wool fat.

The fixed or fatty oils are much influenced by air and moisture; oxygen acts upon them all to a greater or less extent. Linseed oil is much affected; sperm and olive oils are not much changed. Absorption of oxygen means the development of heat, and this is most pronounced where we have the greatest absorption. The absorption of oxygen causes the formation of a hard, resinous mass which sticks to bearings, which process is known as "gumming." The less the tendency to gumming the better. If linseed oil be poured on a piece of cotton waste, the development of heat, due to oxidation, is often sufficient to cause a charring of the cotton, or the heat so developed may be sufficient to cause the cotton waste to burst into flames. Hydrocarbon oils have this advantage, that they do not oxidise, and if a hydrocarbon oil be mixed with a fatty oil it prevents to a great extent the absorption of oxygen.

The Effect of Water on Fatty Oils.

Water acts also on the fatty oils, decomposing them and splitting them up into their constituents—glycerine and fatty acids. This action is much accelerated by heat. It is evident,

therefore, that if there is much moisture (or water) in a lubricating mixture of hydrocarbon and fatty oils, the interior of the crank case is quite a suitable place for this decomposition process to take place. Glycerine, being a neutral body, will do little, if any, damage. A different story has to be told of the other constituents—the fatty acids. These attack brass and copper very readily, but iron not so readily, and they combine chemically with metals to form a sort of greasy soap.

A simple method of testing lubricating oils is to place a spot of each side by side on a piece of white blotting paper, putting the paper in contact with steam—a steam heater, for example. The oil which penetrates the blotting paper quickest and spreads widest over is always the poorest and thinnest oil, as it shows by its lightness and the quick disappearance of its outer ring that it is compounded from products of very light specific gravity.

If on being exposed longer to steam the oil on the paper disappears entirely, the sample is composed of petroleum oil. If the oil under examination be compounded from petroleum with an addition of lard or other fatty matter, the blotting paper will retain its translucency in the centre long after the petroleum, which at first spread rapidly over and through the paper, has disappeared.

Petroleum penetrates blotting paper faster than fatty oils do, and also spreads wider over the paper at first, but it dries off rapidly and the translucency disappears, while that of the fatty oils remains.

Some of the fixed or fatty oils turn rancid (unlike the petroleum oils), and when this occurs the fatty acids are set free and act detrimentally to metals. A simple test for free fatty acids in oils is to pour a small quantity of the suspected sample into a test tube with some fresh brass shavings ; if the oil turns green it is a sign of free acids in the sample of oil.

Drying Oils.

There is still another sub-class of fatty oils, which are termed drying oils, owing to the fact that if exposed to the atmosphere they very readily become hard and resinous, *e.g.*, castor oil, linseed oil, nut oil, and resin oil. These particular oils should not be used for lubricating purposes on account of this property ; they will gum readily.

In order to ascertain the gumming qualities of an oil, some of it should be spread in a very thin layer on a piece of glass, with a cover over it to protect it against dust. This

is then exposed to gentle heat—sunlight, for example—when in a short time the gumming of the oil will be made manifest by the tough and sticky substance which remains on the glass.

Whether the oil used for an engine be a pure hydrocarbon or a mixed oil really matters little to the motorist so long as the oil is the product of a reputable firm. Good oil firms have too much to lose to put upon the market an unsatisfactory article, so that the motorist can rest assured that if it be a mixed oil he is using, the fatty elements in the mixture will be in such proportion that even though they are chemically split up into glycerine and fatty acids in the crank case, they will do no damage to the metals therein.

A Test for Adulteration.

The car owner of enquiring turn of mind may, however, make some further tests for himself which will give a good idea of both the composition and possible adulteration of the oil he is using.

The alkali test will determine whether the oil is a pure fatty or hydrocarbon oil, or a mixture of both. A solution of caustic soda ($NaHO$) of specific gravity 1.340 is prepared, and two volumes of this solution are added to four volumes of the oil under test. The whole is well shaken. and after standing for a time, the oil separates out, leaving an aqueous layer, as a rule, slightly clouded.

If hydrocarbon oil be in the preponderance it will form a layer on the top, and the aqueous layer will be emulsified. If fatty oil forms the bulk of the mixture, the smaller proportion of hydrocarbon oil will be more difficult to detect; a small piece of caustic soda ($NaHO$) is dissolved in 5 c.c. of alcohol, a few drops of oil are added, and the mixture is boiled for a few minutes; then 3 to 4 c.c. of distilled water are added, and if the solution remain clear, only fatty oil is present; hydrocarbon oil, if present, will cause the solution to be turbid (2% hydrocarbon oil will manifest itself by this test).

Acidity or alkalinity in hydrocarbon oil is detected in the following way: Mix a sample of oil with an equal quantity of hot water—say in a test tube—pour off the oil when settled, and test the remaining water with litmus paper. If the blue litmus paper turns red it indicates the presence of an acid—most commonly sulphuric acid (H_2SO_4) from the manufacturing process the oil has undergone; the presence of an alkali will be detected by red litmus paper turning blue.

Colour Test.—This is made by placing twenty to thirty drops of oil in a porcelain dish and adding two to three drops

of strong sulphuric acid. As the acid finds its way through the oil various shades of colour will be noticed till a characteristic colouration will gradually spread through the oil. The mixture should then be stirred and the colour noted ; vegetable oils will give different shades of yellowish brown and green ; fish oils, violet and purple ; animal oils, reddish brown ; hydrocarbon oils, blackish brown.

In spite of all these tests the fact remains that the real and only practical test is that of actual trial in the engine itself, and it may once more be repeated that when a certain oil gives thorough satisfaction it should on no account be changed.

Grease.

It has been shown that from crude petroleum we get semi-solid products as the final process of fractional distillation, *e.g.*, vaseline. This substance forms an admirable basis for the class of lubricant known as grease. In car practice grease is used in screw lubricators, sometimes in gear box and differential, and it goes without saying that the conditions for lubrication are totally different from those which we have previously considered. The lubricant here need not necessarily be of the same high standard as that required for the engine. Thus we find that fatty matter of all kinds—residuum and tar from refineries, tallow, lard, palm oil, resin oil, and petroleum oils—worked to a consistency of semi-saponification with lye or lime water may constitute what is known as lubricating grease.

The Inefficiency of Grease as a Lubricant.

Grease lubricants unfortunately do not lessen the wear and tear of metal surfaces to such an extent as oil lubricants do. This is owing to the fact that the consistency of the grease requires a very considerable amount of frictional heat to be produced ere the grease melts and actually lubricates the parts or pinions intended. This is the great objection to a solid or semi-solid lubricant in gear box or differential. Unfortunately it is only comparatively recently that manufacturers have considered the advisability of making their gear boxes and back axle casings oil-tight. It is of little use putting gear oil or even a semi-liquid lubricant in a box which will not retain it.

Experiments have proved that it takes less power to move machinery lubricated with oil than when lubricated with grease, and a moment's consideration will show that grease is in the wrong place in the lubrication of moving pinions. In the gear box grease is simply cut into channels until such

time as friction has developed sufficient heat to liquefy the mass. All this time, however, there has been loss of power and practically no lubrication of the pinions.

It is a sign of the times to note the growing popularity of gear oil and fluid lubricants in the situations mentioned.

In conclusion, a typical recipe for lubricating grease is given from an authority on the subject:

Petroleum oil	40 gallons.
Yellow grease	50 lbs.
Resin	60 lbs.

This is heated to a temperature of about 240° F. and 2 to 2½ gallons of soda lye are added gradually, the whole being well mixed and stirred. The mass will set when cold in about twelve hours, and is then ready for use. Sometimes such substances as graphite, soapstone, sulphur, and other inert matter are added to grease. These serve only as a cushion for the real lubricant, and their presence will be indicated by gummy hard deposits on the bearings and pinions. (*Dietrichs.*)

Water.

498 Water (H_2O), if chemically pure, consists of hydrogen and oxygen in the proportion of two volumes of the former to one volume of the latter. By weight this would read: H—11.136%; O—88.864%.

If hydrogen gas is passed over copper oxide (CuO) heated to a dull redness, the oxide is reduced to metallic copper, and water is formed by the combination of the hydrogen with the oxygen of the oxide; the loss of weight suffered by the copper oxide gives the amount of oxygen, and if this be deducted from the weight of the water formed, that of the hydrogen is found. This method was first used by Berzelius in 1819 in determining the composition of water; the synthesis of water by weight would be difficult to ascertain accurately by weighing the gases themselves on account of their large volume.

Water in Various Forms.

Water occurs in solid, liquid, and gaseous forms; in the atmosphere as a vapour, the amount of which varies with the temperature, which in the process of condensation produces clouds and fogs, while in the animal and vegetable kingdoms it is present in large quantities, constituting in many cases 50%—or more—of the organism. It is formed not only when hydrogen and oxygen unite, but also when hydrogen acts on various oxides at high temperatures, and when compounds

containing hydrogen are oxidised. It is also produced, along with carbon dioxide (CO_2), during the process of oxidation of the tissues of animals, *e.g.*, in expiration.

The principal use to which water is put by the motorist (apart from washing purposes) is to assist in keeping the engine of his car at a correct working temperature. There is no necessity to discuss the methods employed in cooling the engine, suffice it to say that water, being capable of absorbing a considerable degree of heat, is circulated round the cylinders to the radiator, where (assisted by the fan) the heat is dissipated.

Some interesting experiments have recently been made by a well-known American motor firm—the Thomas Co.—which would tend to show that many motor engines are too efficiently cooled, more especially in winter. A six-cylinder engine of $4\frac{1}{4}$in. bore and $5\frac{1}{2}$in. stroke was used for the experiments, and it was found that at 100° F. (the temperature of the water in the radiator) the horse-power developed by the engine was 51; at 140° F., 54.5; at 160° F., 56.5; and at 200° F., 62.

Thus it will be noted that from actual experiment there was a distinct gain of $5\frac{1}{2}$ h.p. on the increase of the temperature from 160° to 200° F.

Water in thin layers under ordinary conditions is a fluid, colourless, tasteless, and of neutral reaction; in deeper layers it is apparently of a greenish blue colour, while river water is of a brownish tint owing to the organic matter usually contained in it.

Impurities in Water.

Pure water is never found in nature. The nearest approach to absolute purity is got in rain water, and this as it descends through the atmosphere absorbs organic matter—dust, for example—while it dissolves the atmospheric gases.

Rain water is practically distilled water (with the addition of the impurities mentioned), and the latter part of a shower of rain consists of much purer water than the early part, due to the fact that the atmosphere has been well washed previously.

Water has been described as the universal solvent. This is hardly correct, however, as there are quite a number of compounds insoluble in water. If we trace the course of rain after falling to earth, it is not difficult to understand the fact that what are known as natural waters contain a considerable amount of impurities in the shape of organic and inorganic matter. The latter impurities are of moment to the motorist, for if present in quantity the water is known as hard, and is quite unsuitable for motor engine cooling.

Fresh water from rivers and lakes usually contains from ½% to 3% of solid matter, that from deep wells from 1% to 4%. Rain, after falling, permeates through the earth, and dissolves out the inorganic matter with which it comes into contact, the amount of salts, of course, varying with the character of the earth's crust through which the water has percolated. Sandstone and granitic material is less attacked than soils rich in the carbonates of lime and magnesia, so that springs and wells in limestone regions contain much more solid material in solution than those where sandstone and granitic rocks are present.

The most common substances met with in ordinary water are: Sodium sulphate (Na_2SO_4) and sodium chloride ($NaCl$), magnesium sulphate ($MgSO_4$) and magnesium carbonate ($MgCO_3$), calcium sulphate ($CaSO_4$) and calcium carbonate ($CaCO_3$), and silica (SiO_2), while well waters of certain localities —in large towns, for example—often contain salts of nitric acid (HNO_3), nitrous acid (HNO_2), ammonia (NH_3), and carbon dioxide (CO_2).

Hard and Soft Water.

According to the presence or absence of solids, we may classify water as hard or soft. The test for a hard water is quite easily made with a piece of soap, which, rubbed between the hands in rain water, lathers readily and its cleansing powers are very quickly brought into action, but if a spring water containing the aforementioned salts is used, the soap must be rubbed for a much longer time before a lather occurs and a white flaky substance is seen in the water.

The explanation for this is simple. Soap is formed by the combination of a fatty acid with an alkali, oil or fat being boiled with potash or soda. In the preparation of ordinary hard soap the soda extracts from the oil or fat two acids —stearic and oleic—and unites with them to form soap (known chemically as a mixture of stearate and sodium oleate). Now, if soap is dissolved in soft water, and a little of a solution of magnesium sulphate added, the soap water will lose its power of frothing or lathering owing to the decomposition of the soap by the magnesium sulphate (forming sodium sulphate), and the curdy flakes are produced, consisting of stearate and magnesium oleate. This is exactly what happens on attempting to produce a lather with soap in hard natural waters.

Hard water when used in the radiator for cooling purposes is extremely apt to produce a condition known as "furring," and if the pipes and radiator tubes are of small bore, there is a tendency to considerable diminution in the bore of the

tubes, and possibly overheating due to this "fur" being deposited. Engines having pump circulation are of necessity more liable to suffer, as the diameter of the pipes is not so large as in thermo-syphon circulation.

The household practice of putting a marble in the bottom of the kettle in localities where hard water is common is well known—Coventry and London water is exceedingly hard when compared with, for example, that of Glasgow.

The writer has seen the outlet pipe of a radiator with its bore diminished by one-half owing to the solid incrustations deposited from hard, unsuitable water. This incrustation is of a white or brownish colour, and is composed principally of calcium carbonate in very minute crystals. It may also contain other salts of magnesium and calcium, hydrated iron oxide (rust) and organic matter, to which is due the brown colour of the deposit.

When water which has been boiled for some time is compared with unboiled water from the same source, it will be found to have become much softer owing to the separation of some of the calcium and magnesium salts from the water; the amount of hardness thus got rid of is known as temporary hardness to distinguish it from the permanent hardness due to the salts which still remain in the boiled water.

The addition of washing soda to water containing salts in solution removes not only the temporary but the permanent hardness—the calcium and magnesium sulphates are decomposed by the washing soda, which separates them as insoluble carbonates, while sodium sulphate remains dissolved in the water. There is no intention, however, of suggesting that the motorist should think of using this method of softening hard water for use in his radiator; in localities where the water is hard, nothing else but rain water is fit for cooling purposes on account of the deposition of "fur" which comes from the use of hard water. This fur, of course, may be got rid of in the cooling system by washing out with a dilute acid which dissolves the salts, but the important point to remember is that fur should never be permitted to deposit in the pipes and radiator at all, prevention being far more preferable to cure in this case.

Water boils at 212° F. and freezes at 32° F. In a recent article in *The Autocar* on anti-freezing solutions it was pointed out that certain substances, *e.g.*, alcohol and glycerine (which are miscible in all proportions with water), when added to the water lowered the freezing temperature of the cooling solution. In the article referred to tables were given showing

the percentages of the substances used in the water and the different freezing points of the resulting mixtures. A table is here given of the boiling points of different proportions of alcohol and water, which may be of interest.

Alcohol percentage by volume in the boiling liquid.	Temperature of the vapour in degrees Fahrenheit.
0	212
1	210
2	208
3	206
5	203
10	198
20	190
25	187
50	178
92	171

(*Bayley.*)

It will be noted that, even with the large percentage of 92 of alcohol in the liquid, the boiling point is 11° F. removed from the temperature at which alcohol boils—160° F. Five per cent. of alcohol added to the cooling water is quite sufficient to ward off any ill-effects of frost in this country, and is assisted by the addition of a similar amount of glycerine; note the boiling point of a 5% mixture—203° F.—which constitutes an absolutely safe mixture for ordinary use.

Water is but slightly compressible—a litre of water at 68° F. under a pressure of two atmospheres is diminished in volume by only 0.046 c.c. The volume of water varies with the temperature; it expands in volume when heated above 39.2° F., and also when cooled below that temperature to 32° F.; the maximum density is, therefore, at 39.2° F.

Most substances show a continuous diminution in volume when cooled, and the expansion of water on freezing is rather a remarkable property of the fluid. This property of expansion on freezing has unfortunately been made manifest in the shape of cracked cylinders and burst pipes after a night's unexpected frost.

Super-cooled Water.

Ice melts at 32° F., but when water is cooled to this temperature it does not necessarily freeze. In fact, water may be cooled several degrees below zero and still be liquid, and in this condition it is said to be super-cooled, or in a metastable condition. If water thus snper-cooled is brought into contact with a piece of ice the whole mass instantly freezes. If super-cooled water is still further cooled, a point

is reached at which it will congeal without being touched by ice. Super-cooled water may be kept a long time in the liquid condition, and sometimes stirring or shaking will induce freezing, more particularly if the temperature is very low.

The freezing and melting points of water are the same —32° F.—and at this temperature ice and water are in equilibrium with each other at ordinary pressure. If the temperature is raised above 32° F., all ice disappears; cool below this temperature in the presence of ice, and the whole mass freezes—all water disappears.

Tyres.

499 The tyre is, without question, the most unsatisfactory item in the outfit of the complete car; it may safely be formulated that were it not for the pneumatic tyre the modern motor could be designated an absolutely reliable vehicle in every respect; and by the same token, were it not for the pneumatic tyre, the modern motor car would not have reached such a stage of perfection.

Taking all things into consideration, however, a good tyre responds right nobly to the demands made upon it, provided that reasonable care be taken. The making of a tyre is partly a chemical process, not too well understood, unfortunately, and the motorist who understands a few chemical and physical facts with regard to his tyres is on the rght road to diminish his tyre bill considerably.

As it is with the finished product that the motorist has to deal, it would be out of place here to dissert on the chemical properties of pure rubber; suffice it to say that the analysis of chemically pure Para rubber shows the following: Carbon 85.82%, hydrogen 11.11%; or in other words, the chemical formula would read (C_5H_8)—carbon five parts, hydrogen eight parts. Thus pure rubber is designated a hydrocarbon. Needless to say, the crude or pure rubber of commerce would be absolutely useless for motor work; it must undergo certain mechanical and chemical processes before it emerges as a motor tyre.

The manufacturer has, for instance, to subject the crude rubber to the process known as washing, and the loss in washing is a very important factor in the commercial side of tyre making. Thus in a cheap rubber such as Dead Borneo this loss may reach the enormous total of 70%, while in best quality rubber—Ceylon Plantation Para—the loss is only about 2%. It will thus be noticed that it does not pay the manufacturer to use inferior rubber. The next step in the process is the

drying of the washed rubber, and this has to be very carefully done, for if the temperature of the drying room be too high, only the superficial moisture is extracted, because the surface of the rubber contracts and prevents the moisture in the deeper parts from getting free. Unless freed from moisture the chemical action known as oxidation occurs, which causes rapid deterioration of the rubber.

Next follows the mixing. Each manufacturer uses certain substances to give " body " to the rubber, enabling it to perform its function as a tyre. A typical " mix " is here given :

Congo	10,000 parts
Pitch	1,000 ,,
Reclaimed rubber	8,000 ,,
Litharge	750 ,,
Whiting	3,000 ,,
Sulphur	1,500 ,,
Dark substitute	10,000 ,,

(*Heil and Esch.*)

The mixing also has to be carefully performed in order to get a perfect homogeneity of the mass, which is then rolled into sheets ready for vulcanising.

VULCANISATION.

The term " vulcanisation " is used to describe certain chemical reactions which the mixture undergoes in order to fit it for a car wheel. This term is, however, rather unsatisfactory, for the phenomenon which is included under the name vulcanisation is only the first stage of a series of transformations which the hydrocarbons constituting rubber undergo under the influence of mixed temperature and in the presence in excess of a vulcanising agent. In other words, the chemistry of the pneumatic tyre is unsatisfactory, inasmuch as the completion of the chemical action is not reached until the rubber compound is properly vulcanised to the stage where the finished product is known as " vulcanite " or " ebonite." This latter material, being hard and brittle, is quite unfit for the making of a tyre, so that in the making of a tyre the manufacturer stops the chemical process when it is half completed.

The discovery of the process of vulcanisation stands to the credit of an American, Charles Goodyear, in 1839, and it is interesting to note that in vulcanising by heat the methods of Goodyear and those of to-day are practically identical. The discovery was not accidental, but was the result of much labour and research.

The process is based on the cold mixing of a predetermined quantity of sulphur with rubber, and the transformation of this mixture into vulcanised rubber by a fixed degree of heat. Results are attained by this method which have not been surpassed by any other.

The rubber, masticated and dried, is mixed with 7% to 10% of sublimed sulphur. This mixing must be most thorough to form a homogeneous mass. The substance is then passed repeatedly through rollers, the space between them being diminished as the operation proceeds. As the mass emerges from the rollers the sheet is dusted with sulphur, and again passed through the rollers; this is repeated as often as necessary completely to exhaust the sulphur; the rubber sheet is then worked into shape and vulcanised.

The vulcanising agent most commonly used is sulphur, which is used in excess (vulcanisation is possible with only 2% to 3% of sulphur).

By the way, as free sulphur is present in a newly made tyre, it is always wise to keep the tyre for at least two months after it leaves the factory; by that time what is known as the "bloom" will have appeared on the surface of the tyre. This is due to the excess of sulphur finding its way through the substance of the rubber to the surface. This bloom is commonly mistaken for French chalk.

The chemical actions which occur in vulcanisation have not as yet been satisfactorily explained. Vulcanisation is supposed to be the result of an absorption to the extent of 2% of sulphur, but the nature of the absorption is not yet settled. Some declare that vulcanisation is a true chemical action, a chemical compound being formed as the result of the action of heat on rubber and sulphur. This would seem to be proved by the fact that rubber and sulphur, both soluble in carbon bisulphide (CS_2) before being exposed to heat are insoluble in this fluid afterwards.

In view of such conflicting testimony, vulcanised rubber may be described as a sort of alloy of the organic substance of the rubber with sulphur or with a metallic sulphide. (Sulphides of metals also act as vulcanising agents.) This condition is not a proper chemical combination in the strict sense of the term from which the formation of a well defined chemical individuality would result; it differs, however, from simple solution or mechanical mixture.

Vulcanisation being an unfinished reaction, it will be evident that it is impossible to ascribe to the product a proper chemical formula, for a reaction interrupted from one moment

to another cannot be formulated, and we must be content with a demonstration of its properties, especially in contrast with those of pure rubber.

Normal rubber has a density of 0.925; when vulcanised the density reaches 1.20 or even more. It is evident that this density is only produced by an excessive loading with inert matter. Vulcanised rubber is a worse conductor of heat and electricity than normal rubber, and this becomes more pronounced in proportion as the transformation becomes more complete. Sulphur, like rubber, is a bad conductor of heat and electricity; the two combined by alloy, or by chemical combination, therefore totalise the sum of those properties so as to render vulcanised rubber one of the best of non-conductors.

The porosity of vulcanised rubber is less than that of natural rubber, and according to Julkowski's experiments, vulcanised rubber has the property of removing from coal gas a portion of its illuminating power by the absorption of the heavy hydrocarbons. It was proved that an illuminating gas of 13.2 candle-power was reduced to 10.7 candle-power by passing it through a rubber tube 14ft. long. Rubber when kept in contact with coal gas for fifty-one hours absorbed 3.64% of its weight of hydrocarbon which it gave off slowly in free air. This will account for the unpleasant odour when rubber tubing is used for the conveyance of coal gas, and be it noted that the rubber actually extracts the hydrocarbons of the gas—a true dialytic action.

Hempel's experiments proved the absorptive property of rubber when in contact with carbon dioxide (CO_2); for example, the rubber behaves exactly like a liquid solvent. Fragments of rubber were placed in a graduated flask containing carbon dioxide gas until the graduations indicated absorption; the unabsorbed gas was then replaced by air. It was found that small fragments of rubber 3 cm. long and 4 to 5 cm. in diameter had absorbed 2 c.mm. of carbon dioxide gas.

The foregoing is interesting to the motorist, as it explains why atmospheric air is the best gas to use for the inflation of tyres. Even in the use of air (which is a mixture, not a chemical combination), some of the oxygen is absorbed by the rubber and some passes through the walls of the tube, so that it is really the nitrogen of the air which is of most use in keeping the tyre inflated; nitrogen does not diffuse readily through rubber.

Elasticity, extensibility, and compressibility are important properties of vulcanised rubber, the process of vulcanising

having modified and developed those properties to the great advantage of the raw material. Stewart has proved that best Para rubber, vulcanised, has lost none of its elasticity after being kept under suitable conditions for eighteen years.

The Incompressibility of Rubber.

Throughout all the different shapes which a mass of vulcanised rubber may be made to assume, its volume remains constant; in the case of a tyre its average diameter extends in the same proportion as the meridional section diminishes. Lord Kelvin has stated that "clear elastic jellies and india-rubber are probably all of the same compressibility as water" (1873), which is equivalent to saying that rubber is incompressible to the same extent as liquids.

Those properties just mentioned are of interest, for they come into play in the running of the tyre. Thus during the deformation of a circular band of rubber, the substance flows slightly towards the interior, much towards the exterior, producing considerable surface tension; even rupture does not lead to true permanent deformation.

Pure rubber (unvulcanised) possesses the property of adhesiveness; this is entirely destroyed by vulcanisation.

The Effect of Light and Heat.

The motorist is recommended to keep his tyres in a cool, dark place, and we may well investigate the reasons for this. Light acts in a most destructive fashion on normal rubber, and more so on vulcanised rubber, and this is all the more noticeable when an elevation of temperature occurs.

If we had a well defined chemical substance to deal with, much might be learned from the study of the changes which rubber undergoes in air, light, heat, and humidity. This study might furnish means of correcting the inherent defects of the transformed rubber. But, as previously pointed out, rubber as we get it for motor work in the shape of tyres and tubes is only the result of an incomplete and intermediate transformation between pure rubber and vulcanite, and it is practical experience alone which will teach us what is good and what is bad for vulcanised rubber as we have very little definite chemical knowledge to guide us.

Loss of Elasticity.

Tyres deteriorate in various ways. If exposed to heat, light, and moisture, molecular changes occur, and a type of fermentation occurs, causing a distinct loss of elasticity in the tyre. Further deterioration occurs in the form of cracks on

the surface exposed to the air. The rubber feels hard, and is easily pulverised. Now, remembering the fact that the tyre is imperfectly vulcanised as we get it, it seems as though this atmospheric combination were capable of continuing the vulcanising process—it does so, as a matter of fact. The tyre exposed to air and heat is simply undergoing slow vulcanisation towards the stage which we know as the completion of the process—vulcanite or ebonite.

It must not be forgotten, however, that along with this continuance of the vulcanising there is also true deterioration of the rubber itself. The rubber oxidises, hard brittle resins are formed, also a soft greasy substance; and this deterioration is not always equally distributed over the surface. It sometimes occurs in patches; this would point to a fault in manufacture, either in mixing or imperfect drying.

Chapel goes so far as to state that the lunar rays are also fatal to vulcanised rubber, while Seely found that rubber, mixed with free sulphur, vulcanised equally as well under the action of light as of heat. A thin sheet of rubber applied to a lithographic stone and exposed to sunlight can impart to the stone the property of retaining printing ink on the isolated spots; this phenomenon is explained by the fact that there is no disengagement of light without a simultaneous disengagement of heat.

Action of Oils.

Rubber forms with oil a plastic mass, which very rapidly oxidises; palm oil acts most energetically, castor oil very slightly. The fabric of a tyre must be entirely free from oil before the rubber is vulcanised to it, as more than 1% of oil in a fabric is fatal to rubber.

Action of Solvents.

If vulcanised rubber be immersed for a time in essential oils—benzol, carbon disulphide—it does not dissolve, but swells considerably, and when the solvent has been completely eliminated the properties of the rubber so treated are much modified. Ether dissloves 4% to 5% of vulcanised rubber, and also any excess of sulphur.

Action of Acids, Alkalies, and Metals.

Vulcanised rubber resists acids, alkalies, and salts better than normal rubber, and this leads to a very important matter —the action of rubber in the presence of a metal, *e.g.*, iron or copper. These metals in contact with rubber become corroded, and reciprocally react on the rubber. The sulphur in excess has most likely formed a metallic sulphide, or perhaps the

affinity of the sulphur for the iron or copper is greater than for the rubber, the metals become coated with a layer of metallic sulphide, which, besides being injurious to the metals themselves, is infinitely more so to the rubber.

In the manufacture of electric cables, vulcanised rubber must not be applied directly to the copper, for not only would the wire soon lose its conductive power, but the dielectric would also diminish in efficiency.

Steel-studded Tyres.

From the above it will be seen that the reactions which occur between metals and vulcanised rubber are of moment in the use of steel-studded tyres. Taking, for example, a tyre where the steel studs are embedded into the rubber tread itself, it does not take much profound thought to understand why the steel-studded tyre does not give the same "life" as the plain, grooved, or ribbed tyre. Putting aside the harshness of the drive, the biting rather than the rolling action of the studded tyre, there are the questions of chemical action between the rubber and the metal, and the rusting of the metal.

Notice the surface of the steel studs after the car has been off the road for a day or two; each stud is palpably rusted. This process was explained in detail in a previous article, first of all the formation of iron carbonate, then oxidation and hydrated iron oxide—rust. As the stud emerges from the body of the tyre it will be noticed that there is a distinct space between the circumference of the stud and the surrounding rubber; thus the rusting process extends down the stud (to the deterioration of the rubber), while the reaction of sulphiding is proceeding at the base of the stud.

These reactions, along with the destructive processes engendered by the running of the tyre, friction and cuts permitting the ingress of water and sand to the fabric, soon result in the total disorganisation of the tyre as a whole. The fabric is weakened, rots, and sooner or later the inevitable burst results; in addition to this, a hastily taken corner or a misapplication of the brake is almost certain to result in the wholesale pulling out of the studs, thus rendering the admission of water and grit to the fabric an easy matter.

Cold Vulcanisation.

This process is much used in the joining up of the inner tube. The inner tube being free from the friction and hard usage to which the cover is subjected, and requiring to possess above all things the properties of elasticity and dilatability, it must be of much purer composition than the outer cover—

simply pure rubber and sulphur and colouring matter. If the tube be cut out of sheet rubber and made up on a mandrel, the ends must be joined to complete the job. The two ends are brought together on the mandrel, one end being turned into a flap (as one turns up one's coat sleeve), the two surfaces are coated with a solution of pure rubber, then with a solution of sulphur, and the flap is folded over the other end of the tube.

For repairing tubes the motorist is provided with a solution of rubber and a specially prepared patch, and on no account should this solution be applied to the tube with the finger. The natural grease and excretions from the pores of the skin form about the best anti-vulcaniser known, and it follows that, in addition to careful cleaning of the tube (petrol does *not* clean rubber) and the production of a roughened surface with the scratch brush, the solution should be applied to tube and patch with a clean piece of wood, bone, or ivory —an old ivory paper knife, for example.

Acetylene.

500 Acetylene at ordinary temperatures is a colourless gas of specific gravity 0.9056 (taking that of air as unity) and possessing a characteristic ethereal odour.

This gas was first discovered in 1836 by Davy, who, while experimenting with potassium tartarate and charcoal, produced a black compound which decomposed water with considerable violence and evolved a gas. It remained for Berzelius to demonstrate the actual composition of this compound, which proved to be calcium carbide, the gas which was set free being acetylene.

Wohler manufactured carbide as a laboratory experiment in 1863, and in 1892 Willson (of America) and Moissan (of France) found that if lime and charcoal were fused together by the intense heat of the electric furnace, the calcium of the lime united with the excess of carbon to form calcium carbide. So far as is known at present there is no other method of producing carbide, and it is evident that the electric power must be cheap in order that the manufacturing process may be a commercial success; thus an ample supply of water power (if available) fills the bill exactly, and we find that the production of carbide is confined to mountainous countries, principally Switzerland, Norway, Sweden, etc.

CHARACTERISTICS.

Carbide is manufactured in two ways:

(1.) By the ingot process it is produced in lumps,

which are afterwards crushed to pieces of definite size and packed away in air and water-tight drums.

(2.) Run carbide is obtained by reducing the product to the liquid state; this is then run off into containers, cooled, and broken up for commercial purposes. Further, in order to protect it from the action of humidity and premature decomposition, carbide is sometimes "treated," that is, steeped in or coated with a solution of glucose or oil.

The appearance of carbide and its characteristic odour are so well known to the motorist that comment is superfluous. Carbide should not contain more than 5% of dust, and broken into standard size lumps it ought to be capable of yielding 4.8 cubic feet of gas per pound at a barometric pressure of 30in. and a temperature of 15.55° C.

When water and carbide are brought into contact certain definite phenomena are manifested; a double decomposition occurs with the evolution of acetylene.

In this reaction the hydrogen of the water leaves the oxygen, and the carbon of the calcium carbide leaves the calcium; these unite to form the hydrocarbon acetylene; the remaining product or "sludge" is termed slaked lime—calcium hydroxide.

$$\frac{CaC_2}{\text{Carbide}} + \frac{2H_2O}{\text{Water}} = \frac{C_2H_2}{\text{Acetylene}} + \frac{CaOH_2O}{\text{Lime}}$$

Acetylene burns in air with a flame more closely resembling sunlight than that of any other artificial illuminant, being particularly rich in blue and violet light. This prominence of blue and violet renders the flame very actinic, hence its usefulness for photographic purposes.

Numerous experiments have been made to discover the temperature of the acetylene flame. Le Chatelier puts it at between 2,100° to 2,400° C., whilst Catani gives the following figures:

Acetylene and	cold air ..	..	2,568° C.
,, ,,	air at 500°C.	..	2,780° C.
,, ,,	,, 1,000° C.	..	3,000° C.
,, ,,	oxygen ..	..	4,160° C.

Note the intense heat of the latter flame, which is made use of in the arts for soldering and welding.

Acetylene is soluble in many liquids:

100 vols. of	acetone	absorb	2,500	vols. of acetylene.
,, ,,	alcohol	,,	600	,, ,,
,, ,,	petrol	,,	400	,, ,,

Advantage is taken of the high degree of solubility of acetylene in acetone to use a solution of the gas in that liquid when acetylene is wanted in a portable condition. This solubility increases with the pressure, so that under twelve atmospheres acetone dissolves about 300 times its original volume of the gas. The successful solution in acetone depends to a very great extent on the perfect freedom from moisture of the acetylene and acetone, so that acetone of 99% strength is now used as the solvent.

WHEN EXPLOSIVE.

A mixture of acetylene and air becomes explosive when only 3.35% of the mixture is acetylene, while a similar mixture of coal gas and air is not explosive till the coal gas reaches 7.9% of the mixture.

Again, air may be added to coal gas, and it does not become explosive until the coal gas is reduced to 19.1% of the mixture, while if air be added to acetylene, the mixture becomes explosive as soon as the acetylene reaches 52.3% of the total.

It is, therefore, important to avoid, on the one hand, the admixture of air with the acetylene in any vessel containing it or any pipe through which it passes, and also the escape of acetylene into the air of a room.

This danger is all the greater in a situation such as a motor house, where highly volatile hydrocarbons of the petrol type are permitted to vaporise. It takes much less of the vapour of petrol, for example, than of acetylene in the air of a room to bring the mixture to what is known as the lower explosive limit; it is interesting to note, however, that acetylene may be safely "carburetted" in a properly constructed apparatus.

On account of this explosive property of the gas, acetylene has been designated dangerous; much blame has been attached to this most useful adjunct to the car, and if the writer may be excused in saying it, the blame, as a rule, should be on the shoulders of the workman, not on his tools. Given a good generator, not a flimsy soldered contraption, and good quality carbide, the motorist should have no trouble whatsoever from what have been termed "mysterious acetylene gas explosions." Should an explosion occur there is nothing whatever mysterious about it.

The careful reader will have noted two very interesting letters on this subject in *The Autocar* for April 22nd, 1911. In reply to a "mysterious happening," Messrs Charles Bingham make the following pertinent statements, which are well

worth quoting: "If your readers take the most reasonable precautions, they may rest assured that they have much less to fear from explosions from acetylene than from the petrol they use on their cars."

"It is estimated that at the present time there are considerably more than a million motor car and bicycle lamps in use in this country burning acetylene gas, and the accidents with them have been marvellously few. In only two cases, so far as newspaper records go, have these explosions caused the slightest injury."

PRECAUTIONS FOR SAFETY.

The writer has had many years' experience with this type of illuminant both for indoor and car work, and can fully substantiate the remarks of Messrs. Bingham. One unpleasant experience, however, was due to the false economy of purchasing an ill-made generator of foreign origin. Taking all things into consideration, the marvel is that accidents are not more frequent on account of the wilful carelessness of some people.

Take, for example, the condition of affairs in a garage the air of which may be well impregnated with hydrocarbon (petrol) vapour; imagine for a moment the acetylene generator on a car in the garage leaking even only very slightly. Acetylene along with the petrol vapour and air give as happy an explosive mixture as one could well imagine. Presuming even that no naked light be brought into the house, the mere dropping of a shifting key on the concrete floor may produce spark enough to ignite the mixture, or the scuffling of an iron-tipped heel along a stone floor may produce a similar effect.

Acetylene possesses a distinctive odour, and in this lies one of its safe points. The motorist, however, must be in full possession of the olfactory sense in order to detect the gas. It is well known that continuous work amidst odoriferous surroundings is apt to dull this sense, so that there is a possibility that an acetylene leak may be overlooked if one is in the habit of working in an atmosphere of petrol vapour. The remedy is, of course, to pay particular attention to the ventilation of the motor house; one ventilator above is not sufficient. A constant circulation of air should be maintained from the floor upwards, as the vapour of acetylene and petrol lies low.

Acetylene forms chemical compounds with many elements, the most important of which is that in combination with copper. This is readily demonstrated by a simple laboratory

experiment. If the gas be passed through a strong solution of copper sulphate made alkaline with ammonia, copper acetylide is formed. The gas after passing for a time forms a dark brown precipitate, which is collected on filter paper and dried very carefully. This is necessary, as copper acetylene is a most explosive compound; the slightest concussion is quite sufficient to cause its dissolution. In this experiment we have everything at its *best* for the formation of acetylide. When the gas passes from a generator through copper tubing to the head lamps everything is at its *worst* for the formation of the compound.

To quote again from the aforementioned letters: "A crackle has been produced through acetylide forming in the tubes—it is an exaggeration to call those crackles an explosion. By this time everyone should know that copper tubing should not be used for acetylene, as *The Autocar* has more than once pointed out. But even if copper tubes be used, the formation of acetylide is so extremely small that the danger from it is far more remote than from the escape of a few drops of petrol."

The question of the reaction of acetylene on copper is, needless to say, of the utmost importance, for though there is practically no danger in the use of copper tubing for the conveyance of the gas to the head lights, it is as well to be on the safe side, and make use of brass or protected rubber tubing.

Much time and labour have been spent by various scientists in an endeavour to settle the matter definitely, but unfortunately the results have proved extremely unsatisfactory and contradictory.

Gerdes, for example, exposed acetylene for ten months under a pressure of nine or ten atmospheres in vessels made of copper and various alloys; he found that the metals and alloys which resisted oxidation in air resisted the attack of the gas best, that the more corrodible metals and alloys were acted on superficially, and that even then no explosive compound was formed.

Further, if acetylene contained ammonia as an impurity there was distinct corrosion, due to the presence of the ammonia, not to the acetylene. Grittner, on the other hand, states that an explosive compound may be formed after a long space of time if acetylene be in contact with copper and its alloys—brass, for example. Experience has shown, however, that brass is practically unaffected, and may be used with perfect safety under ordinary conditions. At high tempera-

tures condensation occurs between the gas and copper and its alloys, but no explosive is formed.

If a lighted taper be plunged into a vessel full of acetylene the taper is extinguished—the gas is inert—as inert as carbide, for instance, the only precaution for the keeping of which is to have the container water and air-tight. Carbide in proper drums has been recovered from the *debris* of a fire after having been subjected to intense heat and the attentions of the firemen's hose, and found to be in perfect condition.

Generation and Use of Acetylene.

The question of generators does not enter into the scope of this article. We are fortunate in having a good selection of thoroughly reliable well-made tools, which from time to time are described in the columns of *The Autocar*. The main point to be observed is that the purchase should be made from a firm who have a reputation to maintain.

In the chemical process known as "generation" there is a considerable quantity of heat developed. This heat is of importance, for the reassn that excessive temperature inside the generator is detrimental not only to the flow of gas, but to the quality of gas generated. The motorist has, as a rule, to deal with small generators used occasionally and for brief periods, so that undue development of heat is not common.

According to Lewes, acetylene starts to "polymerise" at a temperature of 600° C., and is converted into other hydrocarbons having the same percentage composition, but containing more atoms of carbon and hydrogen in their molecules. Benzene (C_6H_6) is an example of a substance formed thus. Presuming the internal temperature of a generator reached sucha point that polymerisation did occur, this would be manifest from the flame, and for this reason.

Manufacturers in their construction of burners have to take into consideration various data—the density or specific gravity of the gas, for instance. The burner which is suitable for coal gas will not do for acetylene, and *vice versa*. Acetylene requires a definite amount of oxygen (or air) for its complete and successful combustion, and it is found that two parts by volume of acetylene require five parts by volume of oxygen in order to fulfil these conditions. If benzene be formed, however, we know that this latter gas takes much more oxygen for burning than does acetylene—three times as much, as a matter of fact—and thus the resultant flame will become smoky and dirty just in proportion to the amount of benzene present.

Proof of the conversion of acetylene into benzene is also obtained from the appearance of the sludge or spent carbide, which will be unduly dark in colour, and possessed of a distinctly tarry smell. The dark colouration of the sludge is most commonly due, however, to excess of carbon in the carbide or impurities of various types.

Acetylene is an endothermic substance, and is thus liable to decompose into its elements should opportunity arise. This occurs at a temperature of 780° C., or if the pressure under which the gas is stored exceeds 30 lbs. to the square inch. This peculiarity of the gas has possibly given rise to the prevalent belief in some quarters that acetylene is apt to explode spontaneously. Acetylene never does anything of the kind. Even supposing the gas were stored under the pressure mentioned (which is not the least likely, so far as the motorist is concerned), and disassociation of its elements should occur, it would require a spark or a shock of the nature of a fall to the vessel before an explosion could happen, and this in the complete absence of any air whatsoever.

Calcium carbide at its best is never absolutely free from impurities; it contains substances, some of which evolve gas on treatment with water. Other impurities are of such a nature that the gas evolved from crude carbide has to undergo a very thorough system of cleansing and purification before its use is possible indoors. Further, in a badly designed generator we may have additional impurities added to the acetylene, the method of avoiding which is obvious.

The main impurities to be found in carbide may be classed under four heads—substances containing sulphur, phosphorus, silicon, and ammonia, the phosphorous compounds being particularly objectionable, as they in turn give rise to phosphoric acid and phosphoric anhydride; the sulphur compounds give rise to sulphuric anhydrides and their acids. From a health point of view these latter are dangerous, and must be removed by cleansing the gas before burning in a room.

The motorist, however, need not trouble himself on this point, as his use of acetylene is confined to the open air. Care must be taken to avoid the passage of dust through the tubes to the burners, and thus we usually find an arrangement by which the gas is made dust-free by passing it through a container packed with cotton wool.

As an example of how accidents might occur, the following case may be mentioned: A friend purchased a second-hand car, 1906 make, completely outfitted with side and tail lamps, head lights, generator, etc. On using the acetylene out-

fit for the first time the owner noted that there was a palpable escape of gas, and that one head light burned very much better and brighter than the other. The generator was carefully examined; it was of first-class construction, and no fault was found.

On this type of car, however, there were two flanges of wood running along the sides of the bonnet, and these had been made use of to run two lengths of copper tubing for the passage of the gas to the lamps, which tubing emerged from each side of the radiator, and was then connected up to the lamps by rubber tubing.

The copper tubes had been fastened to the woodwork in a most unworkmanlike manner by means of copper staples, the tubing itself being unprotected by cloth or rubber. The result was that the staples on one side of the bonnet had actually lessened the lumen of the tube by more than a half. No wonder the head lights varied in their light-giving power. Further, at the point where both tubes left the radiator it was found that the rubbing of the metal on the tube had resulted in the chafing of the tube to such an extent that the atmosphere round the car was redolent of acetylene.

This method of fitting up an acetylene outfit was as gross an example of carelessness and ignorance as could well be imagined, and it was fortunate that the new owner of the car discovered in time where the actual cause of the trouble lay.

This case might quite easily have formed the prologue to a "mysterious explosion."

In conclusion, the writer begs to acknowledge his indebtedness for frequent reference to that most excellent work, "Acetylene," by the late Mr. F. H. Leeds and Mr. Atkinson Butterfield.

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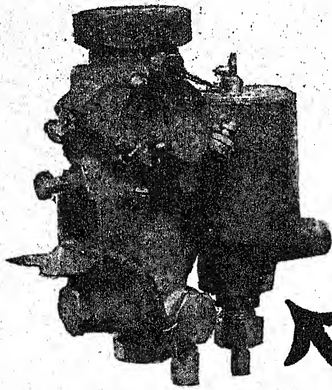

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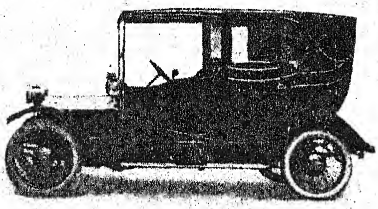

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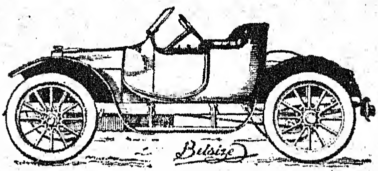

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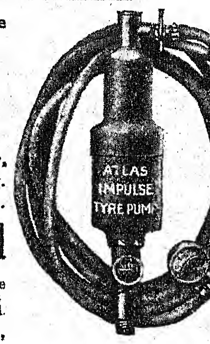

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